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NATO Committee on the Challenges of Modern Society, Brussels (Belgium)

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COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY

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AUTOMOTIVE PROPULSION

Final Report: Automotive Propulsion Systems Pilot Study

CCMS-76

PROPULSION AUTOMOBILE

Rapport Final: Etude Pilote De Systemes Propulseurs Automobiles

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AUTOMOTIVE PROPULSION SYSTEMS
PILOT STUDY

PREPARED FOR THE
COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY
NORTH ATLANTIC TREATY ORGANIZATION

A REPORT BY THE
PILOT STUDY WORKING GROUP

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PREFACE

Article II of the North Atlantic Treaty, which entered into force in 1949, provides that the Parties shall "...contribute toward the further development of peaceful and friendly international relations by...promoting conditions of stability and well-being..." At the 20th Anniversary Session of the North Atlantic Council, held in Washington, D.C., in April 1969, the President of the United States urged the NATO countries to add a new, social dimension to NATO's activities in order "to explore ways in which the experience and resources of the Western nations could most effectively be marshalled toward improving the quality of life of our peoples" and to help 20th century man to learn "how to remain in harmony with his rapidly changing world."

After due deliberation, at its November 1969 Session, the North Atlantic Council formally established the Committee on the Challenges of Modern Society (CCMS) to examine "how to improve, in every practical way, the exchange of views and experience among the Allied countries in the task of creating a better environment for their societies...(and to) consider specific problems of the human environment with the deliberate objective of stimulating action of member governments." The Committee's terms of reference require it to avoid undesirable duplication of work being done in other international organizations.

Recognizing the need for both the short- and long-term development of low pollution power systems, the United States introduced the Low Pollution Power Systems Development (LPPSD) initiative in November 1970 as a part of the already existing NATO/CCMS Air Pollution Pilot Study. As a result, an initial conference on Low Pollution Power Systems Development was held in February 1971 in Eindhoven, The Netherlands. At this conference a Memorandum of Understanding (MOU) was circulated by the United States among the assembled nations. This proposed multilateral agreement was to become the framework for cooperation in LPPSD among auto-producing NATO countries in the future.

On November 14, 1972, at the CCMS Plenary Meeting at NATO Headquarters in Brussels, six nations signed the Memorandum of Understanding. These nations were: France, the Federal Republic of Germany, Italy, The Netherlands, the United Kingdom, and the United States of America. The Memorandum was open to subsequent participation by the relevant governmental agency of other interested countries. Since the signing of the MOU, Canada and Sweden have become active, informal participants in the Pilot Study's activities.

Provisions of the Memorandum call for:

- Direct exchange of technical information among participants
- Annual technical symposia
- Direct collaboration on specific research and development projects

At the conclusion of the Air Pollution Pilot Study in May 1974, it was recommended that the LPPSD initiative be continued under the auspices of CCMS as a separate Pilot Study.

The first symposium under the auspices of the MOU was held in Ann Arbor, Michigan, USA, in October 1973. At that time an Annex to the MOU was signed formally establishing the mechanisms for information exchange. The texts of the MOU and Annex are given in Appendixes A and B. Subsequent symposia were held in Düsseldorf, Federal Republic of Germany, in November 1974; in Rome, Italy, in December 1975; and in Washington, D.C., USA, in April 1977. Complete reference to the proceedings of these symposia is contained in Section VII of this report. A list of the official national representatives from each participating country at each of the four symposia is contained in Appendix C.

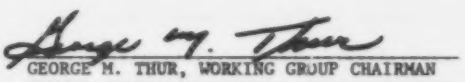
The report, prepared by the Pilot Study Working Group for submission to the CCMS, reviews the essential elements and characteristics of the automotive industry and the fundamental multi-national importance of highway vehicles to the industrial countries of the world. Both the evolution of requirements placed on the industry and the changes in emphasis over the last seven years are discussed to provide a background for the subsequent summary of the technical content of the four international symposia held to date on low pollution power systems/automotive propulsion systems. The apparent trends and directions of development observed from these meetings are identified. Resolutions are made regarding national programs for automotive energy research and development; recommendations are made for future international exchange of information and implementation of research and development activities on automotive propulsion systems. The adoption and implementation of these resolutions and recommendations will insure that the member countries of NATO have recognized the need to deal with this problem in a systematic and dynamic fashion.

The Working Group is composed of:

Canada	-	Mr. A. C. Gullon Environment Canada
France	-	Mr. Claude Lamure Institut de Recherche des Transports
Federal Republic of Germany	-	Dr. Jürgen Bandel Bundesministerium für Forschung und Technologie
Italy	-	Mr. Renzo Strampelli Ministero dei Trasporti
The Netherlands	-	Mr. Johan G. Kuiperbak Ministerie van Verkeer en Waterstaat
United Kingdom	-	Mr. H. G. Dormer Department of the Environment
United States of America	-	Mr. George M. Thur Department of Energy

The Working Group wishes to acknowledge the over 500 scientific and engineering experts from governmental agencies, industries, and research institutes who contributed to the success of the Pilot Study symposia. Additionally, we also acknowledge the encouragement and support of governmental officials in the contributing countries.

Respectfully submitted by the United States of America on behalf of the Copilot countries:



GEORGE M. THUR, WORKING GROUP CHAIRMAN
UNITED STATES OF AMERICA, PILOT COUNTRY

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AUTOMOTIVE PROPULSION SYSTEMS PILOT STUDY

SUMMARY

Pressures of the 1973 oil embargo and the looming depletion of petroleum resources (energy crisis) have stimulated much activity and a sense of urgency about automotive propulsion systems. Highway vehicles (automobiles, trucks, and buses) are vital to the personal life styles and economic well-being of most of the citizens in all of the industrialized nations. At present such vehicles are totally dependent on petroleum-based products.

In view of this situation and the major investment of manpower, money and time required to develop and implement new or significantly different propulsion systems and fuels, the incentives for cooperation, cost-sharing and joint efforts among governments and industries are extremely high. These incentives have served to counter many aspects of the traditional, independent, private and proprietary, competitive method of evolving new automotive products. The need for some sort of government coordination, support and cost-sharing is evident and being implemented.

The NATO/CCMS Automotive Propulsion Systems (APS) Pilot Study has been an important factor influencing and accelerating the trend toward increased international cooperation in the transportation sector--on national, international, and private bases.

The prime effort of the Pilot Study has been devoted to organizing and implementing four international symposia in 1973, 1974, 1975, and 1977 in accordance with the provision of the LPPSD Memorandum of Understanding. Based on the results of these symposia, it appears that we are on the threshold of a new era of increased international, technical cooperation and collaboration focused on the present divergent demands and requirements placed on future highway vehicles.

The symposia format initiated under the Pilot Study is considered very effective and useful for the beneficial exchange of technical information and data on a multilateral basis involving the technical arms of governments and industries:

- The symposia to date have been useful as a vehicle for technical exchanges
- Valuable contacts have been established
- It is an effective way to bring government and industry interests together
- Periodic perspective is established.

The Working Group has agreed that from a technological viewpoint, much stronger relationships and benefits could be derived from projects focused on specific problem areas and development themes. Several areas have been discussed and recommended for initial exploration of specific international cooperative projects:

- Power systems and components
- High temperature materials
- Alternative fuels
- Electric and hybrid vehicle systems
- Harmonization or correlation of emission standards and procedures.

Collaboration in any of these areas may take the form of coordinated research and development programs, exchange of equipment and test results, interchange of personnel, or joint support of specific projects; and may be carried out within existing international organizations, or through ad hoc multilateral or bilateral agreements.

The findings of the Pilot Study have resulted in three resolutions regarding national programs for automotive research and development and in four recommendations establishing a framework for fostering continued international cooperation. These resolutions and recommendations are provided in Section VI of this report.

AUTOMOTIVE INDUSTRY--IMPACT AND CONTROVERSY

A. Significance of Vehicle Transportation

Vehicular transportation of goods and people has become fundamental to the civilized world particularly in heavily industrialized countries and particularly for personal transportation such as passenger cars. The size and impact of this sector on the economy is of increasing importance to industrial countries in terms of employment, capital equipment investment for factories, and both domestic and international commerce (sales). The broad complex of suppliers and support industries--fuel, tires, steel, roads, highways, manufactured components and accessories, and service organizations--further increases the impact and influence of this industry. Broad availability of personal cars and good roads has facilitated changes in living patterns and life styles reflected by the growth of suburbs, decentralization of population centers and shopping centers surrounded by acres of parking lots.

The positive trends have been accompanied by negative factors such as traffic congestion, high levels of traffic deaths, injuries, and property damage, as well as air pollution and complete dependence on petroleum-based products for fuel and lubrication.

Table 1 shows the total transportation oil consumption for passenger and freight usage on a worldwide basis, using 1975 consumption data.

Table 1

COUNTRY	QUADS OF ENERGY USE, 1975 Passenger	Freight
Japan	.7	1.5
U.S.S.R.	1.0	2.8
Advanced Developing (Iran, Saudi Arabia, South Africa, Argentina, Brazil, Mexico, Venezuela)	.8	1.7
Less Developed (India, China, Indonesia, Philippines, Egypt, Morocco, Nigeria)	.7	1.0
E.E.C. (France, West Germany, United Kingdom, Belgium, Italy, Netherlands)	.4	2.4
North America (United States, Canada)	14.6	3.5

B. Significance of Automotive Propulsion Systems

The propulsion system is the heart of any vehicle. The capability, flexibility and low cost of the conventional spark ignition piston engine make it perhaps the one key element which has made automobiles possible. Every vehicle's design and operating characteristics are either determined by or strongly influenced by the engine and its drive train. There are a limitless number of variations in detailed design and physical and performance characteristics which can be used for a large (and still growing) number of applications. Also, existing engine and transmission production lines represent very large capital investments. Unfortunately, in use, the propulsion system characteristics such as excessive exhaust gas and noise can impact on the health and welfare of the community.

Consequently, the possibility or necessity of significant changes in the vehicle propulsion systems immediately attracts major interest from a very broad spectrum of sources and viewpoints. Rapid, significant changes incite much confusion, expense, and attention in all of the auto-producing and consuming nations. Many groups and factions immediately begin to struggle to improve or protect their business position. Because of these intense and very diverse interests and because of the fiercely competitive, independent nature of the industry, the first efforts toward broad international, government-industry cooperation have been ad hoc, tentative, and exploratory in nature.

C. Nature of the Automotive Industry

To try to characterize in a few words the large, complex sector of the economy known as the automotive industry may be difficult. However, some of the salient features may help to put the present

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government-industry situation into perspective and bring out the significance of the NATO/CCMS activities in the Automotive Propulsion Systems Pilot Study.

The automotive industry was started by a number of individuals--inventors, engineers, and entrepeneurs--who established their businesses largely on the basis of free enterprise, competition, and individual accomplishment. They built large profitable organizations largely without government support and regardless of varying amounts of interference from government and labor. Much evolution has taken place with some good and some bad aspects. But overall, the manufacturers have survived or disappeared on the basis of making a product that large numbers of people wanted and could afford to buy--largely the result of well-organized, well-coordinated management and labor, and very large amounts of capital supplied by stockholder/owners of the corporations. Most of the research, engineering, and development was done in-house on a closely proprietary, secret basis. The industry has evolved into a relatively few major corporations and large numbers of suppliers and support organizations. Many aspects of the automotive industry are highly specialized.

D. The Present Trends and Situation

But now the situation is changing. For example, in the United States, starting with the Clean Air Act of 1967 (stimulated by earlier State laws in California controlling automobile emissions) and the Clean Air Amendments of 1970, legal control of automotive emissions became a reality. Stringent requirements and tight time schedules significantly influenced the content and direction of the industry's research and development activities. There seemed to be much duplication of effort. Anti-trust laws in America made cooperative programs difficult to initiate. Then, the oil embargo in 1973 served to focus world attention on energy and the depletion of world-oil resources, resulting in a rapid rise in the price of oil which is expected to continue. The emphasis now has shifted to increasing the fuel economy and using alternate nonpetroleum fuels. This compounds the problem since achievement of higher fuel economy often results in higher emissions, and equipment modifications to reduce emissions usually result in lower fuel economy. Legal requirements for fuel economy levels are being imposed to accelerate fuel economy improvements.

Table 2 shows world demand-supply projections through 1985.

Table 2

Million b/d

	1976	1977	1978	1979	1980	1985
Free World Oil Demand	48.4	49.8-50.5	51.2-52.2	52.5-54.1	54.9-56.7	68.3-72.6
United States	16.7	17.8-18.3	18.2-19.0	18.4-19.7	19.3-20.7	22.2-25.6
OECD Europe	13.6	13.9-14.3	13.8-14.2	13.7-14.4	13.7-14.7	15.8-18.2
Japan	5.2	5.3- 5.4	5.5- 5.8	5.9- 6.2	6.2- 6.6	8.1- 8.8
Canada	2.0	2.0- 2.1	2.1- 2.2	2.2- 2.3	2.2- 2.4	2.9- 3.5
Other developed countries(1)	1.2	1.2	1.3	1.3	1.4	1.9
Non-OPEC LDCs	6.7	7.1	7.5	7.8	8.5	12.0
OPEC countries	2.1	2.3	2.5	2.8	3.0	4.0
Other Demand(2)	0.9	0	0	0	0	0
Non-OPEC Supply(3)	17.5	18.5	20.1	21.2	22.0	20.4-22.4
United States	9.7	9.6	10.2	10.2	10.0	10.0-11.0
OECD Europe	0.9	1.8	2.5	3.1	3.7	4.0- 5.0
Japan	0	0	0	0	0	0.1
Canada	1.6	1.6	1.5	1.5	1.5	1.3- 1.5
Other developed countries(1)	0.5	0.5	0.5	0.5	0.5	0.4
Non-OPEC LDCs	3.7	4.1	4.6	5.3	6.1	8.0- 9.0
Net Communist trade						
USSR-Eastern Europe	0.9	0.7	0.5	0.2	-0.3	-3.5 -4.5
China	0.2	0.2	0.3	0.4	0.5	0
Required OPEC Production	30.9	31.3-32.0	31.1-32.1	31.3-32.9	32.9-34.7	46.7-51.2

(1) Australia, New Zealand, and South Africa.
(2) Including stock changes and statistical discrepancy.
(3) Including natural gas liquids.

After 1980 one can see a larger demand for oil from the Organization of Petroleum Exporting Countries (OPEC); Western European import demand will increase but not as rapidly as the United States.

Regardless of the accuracy of such forecasts and the assumptions on which they are based, the situation is urgent. Immediate short-range steps, aimed at conservation, and longer-range steps, aimed at reducing dependency on petroleum-based energy resources, need to be taken quickly.

Even after decisions are made about what steps should be taken, the time needed to implement significant changes is longer than is generally realized. An additional period is required before the impact of the changes can be reflected in energy demand and requirements. Much research, engineering, and development is required before many of the critical decisions can be made.

E. Need for Cooperation

All industrial nations face similar energy problems. The fundamental technical problems are essentially the same, differing only in degrees and details from one nation or locality to another. They are broad, complex, and require major research and development effort and investment to resolve--particularly to resolve them quickly.

The situation warrants close cooperation between industry and government to accelerate solutions to the problems, not only on a national, but also on an international basis. It is recognized that a great deal of communication and coordination is essential if large duplication of effort and expense is to be avoided.

This seems to be generally recognized, but there are no established procedures or ground rules for doing this. The government, in fulfilling its responsibility to the people, is trying to establish advanced acceptable criteria or standards and to accelerate availability of transportation equipment to the public which will meet their individual needs, not waste energy, or contaminate the environment and at a price the public is willing to pay. The industry shares these goals, but it also wants to maintain or enlarge its competitive position, produce a profit for the stockholders and retain its autonomy. So government and a generally independent automotive industry are being forced to work together by mutual need and common problems. Methods and procedures are evolving, but the initial reluctance and mixed feelings on both sides are understandable.

F. Significance of NATO/CCMS APS Symposia

A very important factor in helping government, industry and the technical community to communicate and understand the technical problems and also (implicitly) some of the administrative and management problems on a multi-national basis, has been the series of NATO/CCMS symposia on Automotive Propulsion Systems which have taken place since 1973. Mutual interest and incentives focus formal and informal discussions on common technical problems among governments, industrial organizations, and individuals. This provides a common focal point. The artificial barriers of nationality and language are minimized in the interest of shedding new light and exchanging information on common technical problems. With strong incentives for solution of such problems, it is easier to resolve the administrative, legal, and political problems. The series of technical symposia supplies the essential ingredient of free and candid communication on the essential issues between the top technical and management official in government, industry, and the world scientific and engineering community.

Specifically, these periodic symposia provide a quick, comprehensive review of the specific problem areas, the status of progress toward their solution, and good perspective of the trends in development. They also provide an opportunity to identify critical areas which may not be getting sufficient attention or effort, and areas where joint effort or cooperative programs would be appropriate to reduce overall cost and accelerate progress.

EVOLUTION OF REQUIREMENTS, SHIFTING EMPHASIS, AND CHANGING SCOPE

The Automotive Propulsion Systems Pilot Study began November 1970 when the NATO/CCMS Air Pollution Pilot Study proposed the Low Pollution Power Systems Development (LPPSD) initiative. At the initial conference on LPPSD in Eindhoven, The Netherlands, in February 1971, the Memorandum of Understanding (MOU) was introduced (see Appendix A). The MOU was signed by the participating countries in November 1972.

At that time the objective was "...to encourage the development and testing of low pollution power systems for motor vehicles (which encompass new types of engines or advanced control systems for the internal combustion engine) in the interest of the health and well being of our peoples..."

Emphasis was on the achievement of low emissions. The U.S. Federal and European emission standards schedules, as well as the U.S. fuel economy standards, are shown in Table 3. In addition to U.S. emission standards, a lead regulation is also in effect requiring refineries to produce fuels containing not more than 0.5 grams/gallon by October 1, 1979.

Table 3

MODEL YEAR	EMISSION STANDARDS U.S. FEDERAL HC g/mi	CO g/mi	NOx g/mi	ECE HC g/mi[b]	CO[a] g/mi[b]	NOx g/mi[b]	FUEL ECONOMY STANDARDS USA mpg	L/100 km
1977	1.5	15	2	8-12.5	50-100	3.6-5.0	18	13.1
1978	1.5	15	2	8-12.5	50-100	3.6-5.0	18	13.1
1979	1.5	15	2	7-11[c]	40-86[c]	3.0-4.5[c]	19	12.4
1980	0.41	7	2	--	--	--	20	11.8
1981	0.41	3.4[d]	1[e]	--	--	--	22	10.7
1982	0.41	3.4[d]	1[e]	--	--	--	24	9.8
1983	0.41	3.4	1[e]	--	--	--	26	9.0
1984	0.41	3.4	1[e]	--	--	--	27	8.7
1985	0.41	3.4	1	--	--	--	27.5	8.6

(a) The 4.5% maximum idle was required to be met at any adjustment of the idle system.
(b) No durability testing required.
(c) Proposed
(d) Waiver for up to 7 g/mi possible.
(e) Waiver for up to 1.5 g/mi possible (Diesel or Innovative Technology).

However, starting in 1974, the issues of energy conservation, energy conversion efficiency improvements, alternative fuels, and electrification were emphasized, considerably broadening the scope of the Pilot Study. The new name "Automotive Propulsion Systems" was adopted to reflect the enlarged scope of activities. The program goals now include energy improvements for all highway vehicle systems (autos, trucks, and buses), the utilization of alternative fuels, and an overall long-term objective of development of a nonpetroleum-fuel base for highway vehicle systems. These criteria, along with the need to meet future statutory emission standards (shown above), appear as design goals in the development work sponsored by each participating nation.

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GOALS AND OBJECTIVES OF APS PILOT STUDY

Provisions in the LPPSD Memorandum of Understanding call for:

- Direct information exchange
- Technical symposia
- Collaborative projects.

As indicated before, the scope and priorities have changed since 1972 and the whole program has taken on added significance relative to the challenges of modern society. The goals are:

- Energy conservation
- Energy conversion efficiency improvements
- Use of alternative (nonpetroleum-based) fuels including a major thrust toward wide application of electric and hybrid vehicle systems
- Safety.

These are the goals for all highway vehicle systems including automobiles, trucks, and buses, which must also satisfy future statutory emission requirements.

The whole program now seems on the threshold of long-term, continued coordination and communication via the international technical symposia. The opportunities for developing meaningful private and government, bilateral and multilateral research and development programs are increasing. Incentives and avenues for developing means of implementing such programs are becoming more apparent as the impact and continuity of the series of symposia begin to be recognized on a broad front.

To date principal efforts have been devoted to the planning, organizing, and assessing the results of the four very successful international symposia. This report is devoted to summarizing the essential elements of these symposia and the progress reflected by the technical content of the presentations.

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INTERNATIONAL SYMPOSIA

A. Overview

Four international symposia have been held to date under the auspices of the NATO/CCMS Automotive Propulsion Systems Pilot Study. These symposia were held as follows:

MEETING	DATE	LOCATION	SPONSORING ORGANIZATION	APPROXIMATE ATTENDANCE
First	Oct. 14-19, 1973	Ann Arbor, Michigan, USA	Office of Air and Water Programs, U.S. Environmental Protection Agency	340
Second	Nov. 4-8, 1974	Düsseldorf, FRG	Ministry of Interior and Ministry of Research and Technology, FRG	+500
Third	Dec. 2-3, 1975	Rome, Italy	Italian Ministry of Transport	Limited to Government Representatives
Fourth	Apr. 17-22, 1977	Washington, D.C., USA	U.S. Energy Research and Development Administration	500

Attendance at these symposia was comprised of a strong mix of technical and management oriented people from: governments, industrial organizations, colleges and universities, and independent consultants, engineers, and scientists from all of the participating and observing countries. (Appendix D lists the participating organizations.) Specific private and government-sponsored programs were reviewed and discussed in an open and candid manner. Technical summary reports were issued for each symposium.

An adjunct to the symposia has been an exhibit of selected vehicles, components, and models to illustrate the programs being reviewed in the technical presentations. This has given participants of the symposia a direct physical grasp of the concepts and equipment involved; it has stimulated questions and ideas; and it has served as a focal point for further information discussion and exchange of viewpoints and observations.

Main themes or lines of development which show continuity through these meetings fall into the general categories listed below:

- Advanced Low Emission, Alternate Heat Engines
  - Stirling Engine
  - Gas Turbine
  - Rankine Engines
  - Rotary Engines
- Conventional Engines
  - Improved Spark Ignition Engines
  - Stratified Charge Engines
  - Diesel Engines
- Transmissions/Powertrain Components
- Accessory Drives

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- Alternative Fuels
- Electric and Hybrid Systems
- Technology Support Programs
- Technology Assessment, Coordination, Systems, and Concept Studies.

In essence, these subjects and/or areas reflect the nature of the government-sponsored work in progress in each participating country.

B. First Symposium, Ann Arbor, October 1973 [1/]

Attention centered on alternative engines and their ability to reach 1976 emission standards. Several papers were presented on gas turbines summarizing the status of the Chrysler baseline gas turbine program, Volkswagen's gas turbine research effort, and low emission burner work by Solar Division of International Harvester. Emissions exceeding set standards, high fuel consumption, and high cost were identified as problem areas. Technology support programs on integrated controls, aerodynamic performance of turbines and compressors, low cost turbine wheel manufacturing methods, and oxide recuperator development were reviewed by AiResearch, National Aeronautics and Space Administration (NASA), Pratt and Whitney, and Owens-Illinois, respectively.

Stirling engine work at Philips Research (The Netherlands), United Stirling (Sweden) and MAN (FRG) was described.

Rankine engine combustion system tests showed very low emission potential. Several prototype programs with different approaches underway at Scientific Energy Systems, Thermo Electron, Lear Motors, Aerojet Liquid Rocket, and Saab-Scania were reviewed, as were plans for the California Clean Car Program. Principal questions surrounding the rankine engine concerned its ability to be packaged in a standard car, and its ability to provide competitive fuel economy at a reasonable first cost.

Stratified charge engine work for the Environmental Protection Agency (EPA) and the U.S. Army Tank Automotive Research and Development Command was discussed. The Volkswagen research results showed the advantages of a divided combustion chamber for reducing NOx emissions. Measurements on a Honda 119 CID CVCC-powered Civic automobile showed very low emissions on the U.S. Federal driving cycle (0.24 g/mi HC; 1.9 g/mi CO; and 0.47 g/mi NOx) with a fuel economy of 20.5 mpg and exhaust gas recirculation.

Progress reports were presented on diesel engine studies by Ricardo and Co. Engineers, Ltd., the U.K. Department of Industry, and an in-house EPA investigation. High NOx, high first cost, large weight, smell, vibration, and smoke were current drawbacks.

Plans for two alternative fuels survey-type studies (just initiated) were reviewed. The longer-term outlook for hydrogen fuel was discussed. A progress report on an electric vehicle impact study for Los Angeles was summarized. Several studies of various approaches to reducing fuel consumption were also included in the agenda.

Many of the programs were still in early stages; only general directions and problem areas could be identified.

C. Second Symposium, Düsseldorf, November 1974 [2/]

Reduction of emissions was still the primary concern, but increased emphasis was given to improvement of conventional internal combustion engines. In addition to low emissions, improved fuel economy had now become a more important factor. Details of combustion system design, ionization processes and reaction kinetics, cylinder air-fuel charge preparation, catalytic exhaust aftertreatment, and stratified charge systems were all covered in technical presentations mainly by the European engine manufacturers and research groups including: Institut für Motorenbau, Universität Kaiserslautern, Institute of Applied Thermodynamics, Robert Bosch GmbH, Ford Motor Company, Deutsche Vergaser GmbH, Honda Motor Company, Volkswagenwerk AG, Porsche AG, Perkins Engine Company, and Daimler-Benz AG.

Advanced engine sessions provided progress reports on the Chrysler and Nissan gas turbine programs, low emission burners at VW and development of ceramic gas turbine components for future high temperature, high fuel economy turbine engines. Reflecting the increased concern for fuel economy, the Chrysler program was redirected from the 150 hp baseline engine in a standard car toward a 100 hp upgraded engine in a compact car. Increased effort was being devoted to ceramic components.

Progress reports on other advanced engines also included the work of Philips and MAN on Stirling engines and Scientific Energy Systems on low emission automotive steam engines. More specific papers were presented on hybrid flywheel systems, hybrid-electric systems, electric systems, and advanced battery development.

Treatment of alternative fuels was expanded. Prime attention was focused on methanol and methanol blends as possible near-term alternative fuels with papers from the FRG, Japan, and the U.S. Hydrogen fuels were also discussed by Daimler-Benz, and Escher Technology Associates.

Review of exhaust emission regulations and low pollution power systems development programs of the LPPSD/MOU signatory countries yielded the following general observations:

- U.S. requirements seemed to be the most stringent. Other countries because of similar air pollution problems in congested industrial areas seemed to be following in the same direction, but at a somewhat slower pace with requirements tailored more to the local geographical areas.

- There seemed to be somewhat less concern for NOx in Europe and more concern for noise, odor, and particulates (smoke).

- At that time there appeared to be almost no concern for emissions and noise from motorcycles and mopeds.

The low pollution power systems development programs all seemed to reflect these observations.

Overview of the trends and activities reflected by the symposium showed most of the technical programs to be proceeding along similar lines toward common goals. These goals were the practical solutions to the difficult problems associated with private motor cars: pollution and damage to public health and the environment resulting from exhaust gas emissions, as well as the public nuisances of noise and odors. Over the preceding year (1973-74), most programs were modified and redirected to take into consideration energy crisis problems. Needed was energy conservation alternate sources of primary energy.

Most of the programs appeared to be complementary with relatively little overlap or duplication of effort.

It was still difficult to get quantitative and meaningful bases for comparing the relative levels and directions of effort in the various countries, but good progress in this direction had been made. It was recognized that if this bases could be established, then duplication of effort and voids in needed research and development activities could be identified and hopefully avoided.

D. Third Symposium, Rome, December 1975 [3/]

Attendance at this symposium was limited to government representatives of the LPPSD/MOU signatory and observer countries. Although each country briefly summarized the status of its own pertinent current program, primary attention focused on action items resulting from the Düsseldorf Symposium and discussion of plans for future directions for the APS Pilot Study. This was a working session devoted to assessment, planning, and strategy.

Action items from the 1974 Düsseldorf Symposium and the new business discussions included:

- Interaction between LPPSD and RSV (Road Safety Vehicles) projects

- Analysis of exhaust emissions test methods and measuring procedures in Europe and the U.S.A.

- Bilateral or multilateral cooperative research and development projects.

The essential elements of these discussions are summarized here:

1. Interaction Between LPPSD and RSV Programs

In comparison with the very difficult safety goals for the RSV, the energy and environmental goals are more readily achievable with current technology. It was anticipated that the final designs delivered in October 1976 would incorporate the best available gasoline or diesel

engines with conventional powertrains. The requirement that these RSV designs be producible on a near-term basis virtually precluded the use of very advanced engine or driveline concepts.

When the RSV designs are completed, however, the highly advanced safety performance of the basic vehicle structure and occupant protection systems could well become the foundation for a second generation RSV, targeted for the 1990 era, that would incorporate engine and powertrain concepts being developed in APS. In this way, truly practical prototype vehicles could be developed in stages. One generation would offer advanced technology in one dimension (such as safety for the current RSV's) while incorporating the best current technology in others (i.e., engine and powertrain). The next generation could build on the advances of the first, with a new dimension chosen for the truly advanced features while others held to the best available current technology.

Such an approach might simplify the problems of trying to advance and optimize too many complex variables simultaneously. To this end, it was proposed that the RSV final design be used as a base for implementing practical new developments surfacing in APS.

2. Analysis of Exhaust Emissions

At Düsseldorf it was agreed to designate some members to investigate the implementation of different projects. In this connection, the Federal Republic of Germany consented to investigate the project, "Possibilities of Harmonizing the Legally Provided Test Procedures for Exhaust and Noise Emissions in the United States and Europe."

To obtain scientifically certain results on this complex subject, three R&D projects were given to industrial establishments (VW, Porsche, and British Petroleum). The total cost would amount to 2.5 million DM (one million dollars) and the projects would take two years, ending by mid-1977.

The following is a brief survey of the first activities: in view of capital shortage, the agreements made at the 1974 symposium aiming at harmonizing the noise emission measurements could not yet fully be realized. Projects dealing with measurement of pollutants were initiated, but the intended investigations on noise emission measurements were expected to be carried out only after the projects mentioned above were completed. Within another scope, however, the FRG Federal Ministry of the Interior planned a project covering the problem area of "noise emissions from motor vehicles and pertaining measurements" which would cost 6 million DM and would run over a period of four years.

3. Bilateral or Multilateral Cooperative Research and Development Projects

The worldwide recession in 1975 made it more important than ever to cooperate, share and not duplicate programs. This was the reason for and purpose of the "Overlay Project," initiated at Düsseldorf in 1974. An overlay of all activity related to APS was determined to be necessary: to allow for better planning in the future, to have knowledge of the money being invested in various areas, and to determine overlap in programs among the various nations.

Although the Overlay Project was not complete, the major portion of the study had been accomplished. For the first time a tabulation was available of the various programs related to alternative power systems and low pollution power systems being developed. After compiling the data contributed, the interest, technology and activity reflected by this summary was impressive. This was particularly true in the areas of emissions, advanced new engines, electric cars, and new fuels. Industry-sponsored programs were not included; the summary was comprised primarily of government-sponsored programs.

To complete the Overlay Project, it was planned to have the current tabulations serve as an index to other important aspects of the listed programs, such as short program descriptions, goals, objectives, etc. This Overlay Project is seen as a continuing activity requiring annual updating as new programs and changes occur.

The various activities are divided into three categories (Figs. 1, 2 and 3). Category 1 encompasses vehicle systems, various emissions and technology assessments. Category 2 includes those items pertinent to advanced heat engines, such as gas turbines, diesel engines, etc. Category 3 includes alternative fuels, electric and hybrid vehicle systems and also material development. In addition to the three categories, the abstracts are broken down by country; similar technologies are identified by the cross-hatch code. It should be observed that there is a lot of activity.

CCMS/LPPSD OVERLAY

CATEGORY ONE; VEHICLE SYSTEMS, NOISE, EMISSIONS & TECH. ASSESSMENT

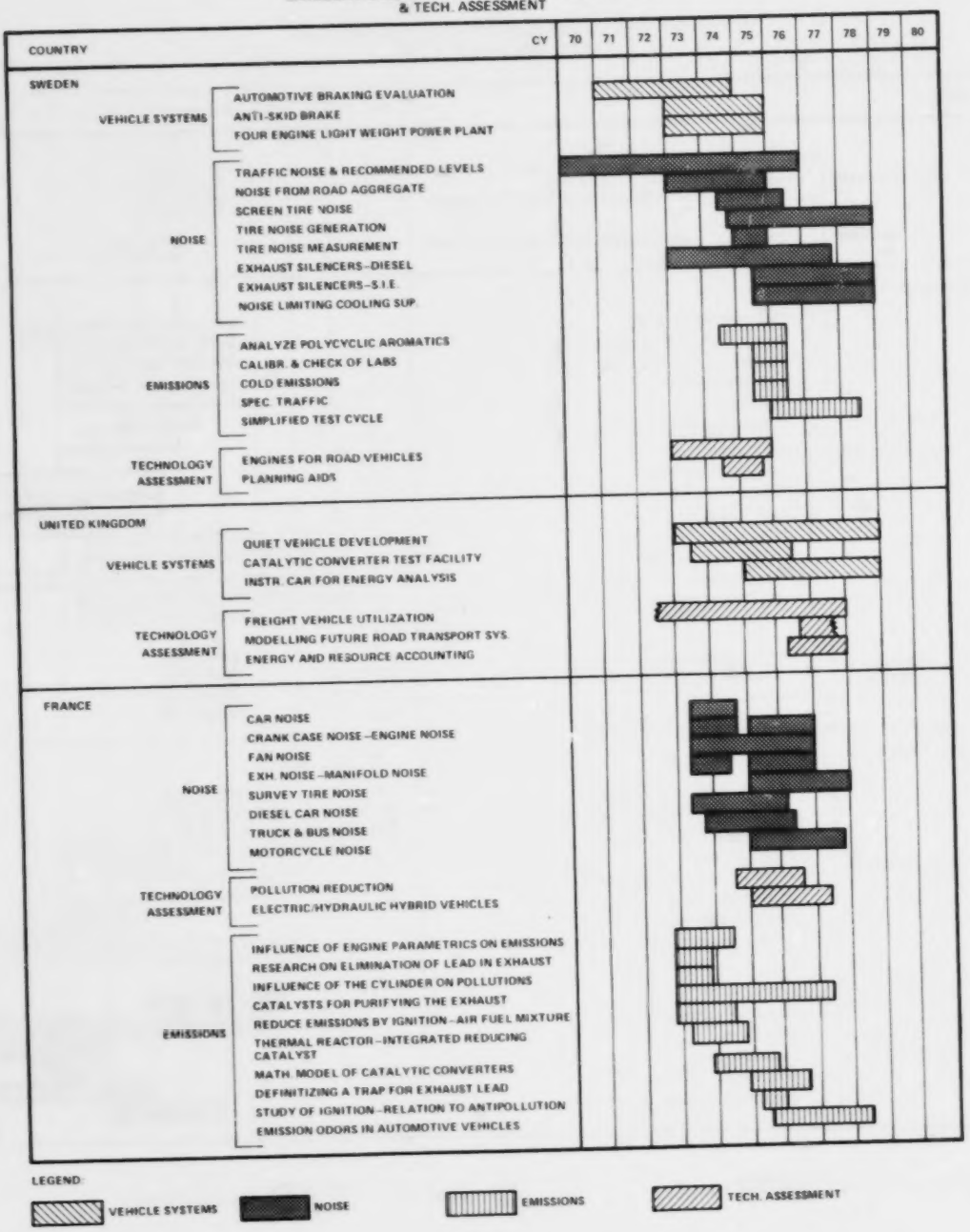


Figure 1

CCMS/LPPSD OVERLAY

CATEGORY ONE; VEHICLE SYSTEMS, NOISE, EMISSIONS & TECH. ASSESSMENT (CON'T.)

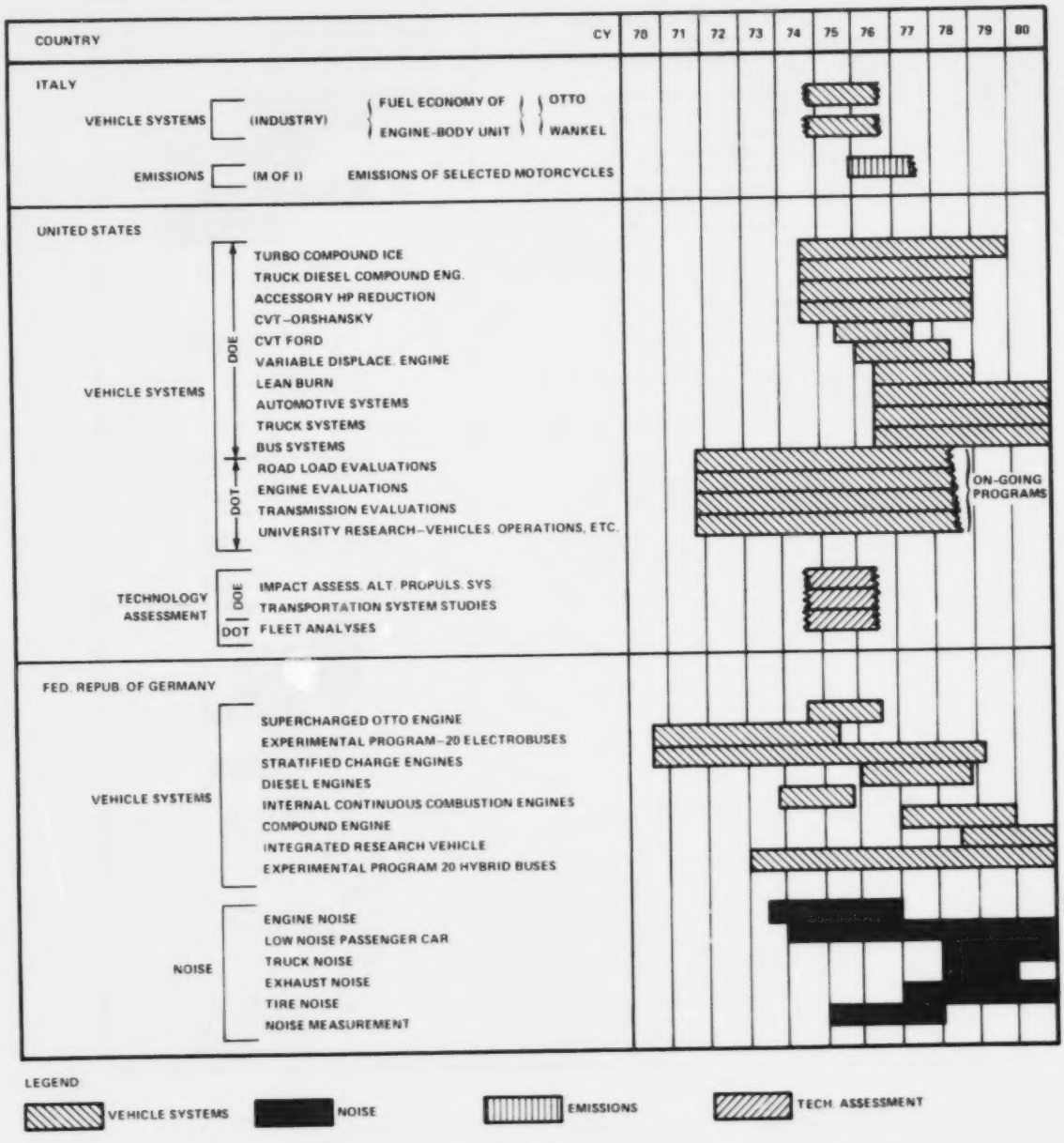


Figure 1 (cont.)

CCMS/LPPSD OVERLAY

CATEGORY ONE; VEHICLE SYSTEMS, NOISE, EMISSIONS & TECH. ASSESSMENT (CON'T.)

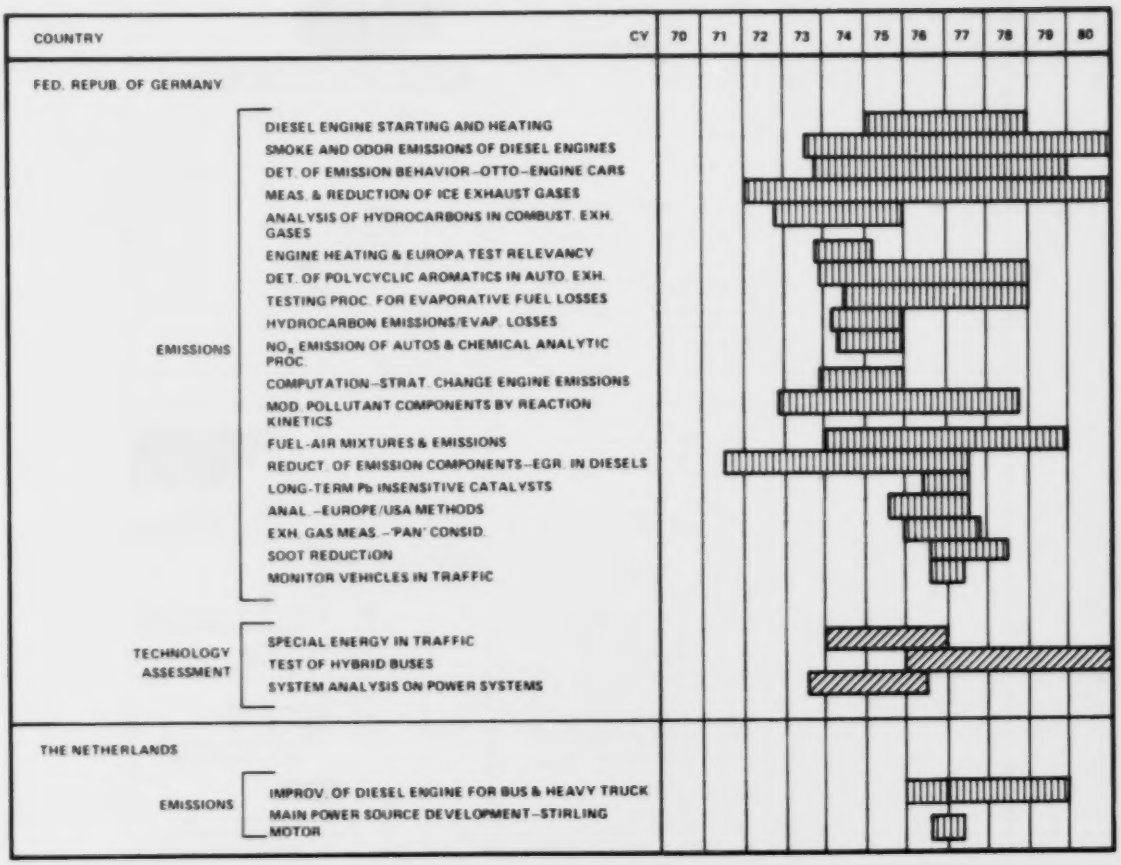


Figure 1 (cont.)

CCMS/LPPSD OVERLAY

CATEGORY TWO: HEAT ENGINE DEVELOPMENT

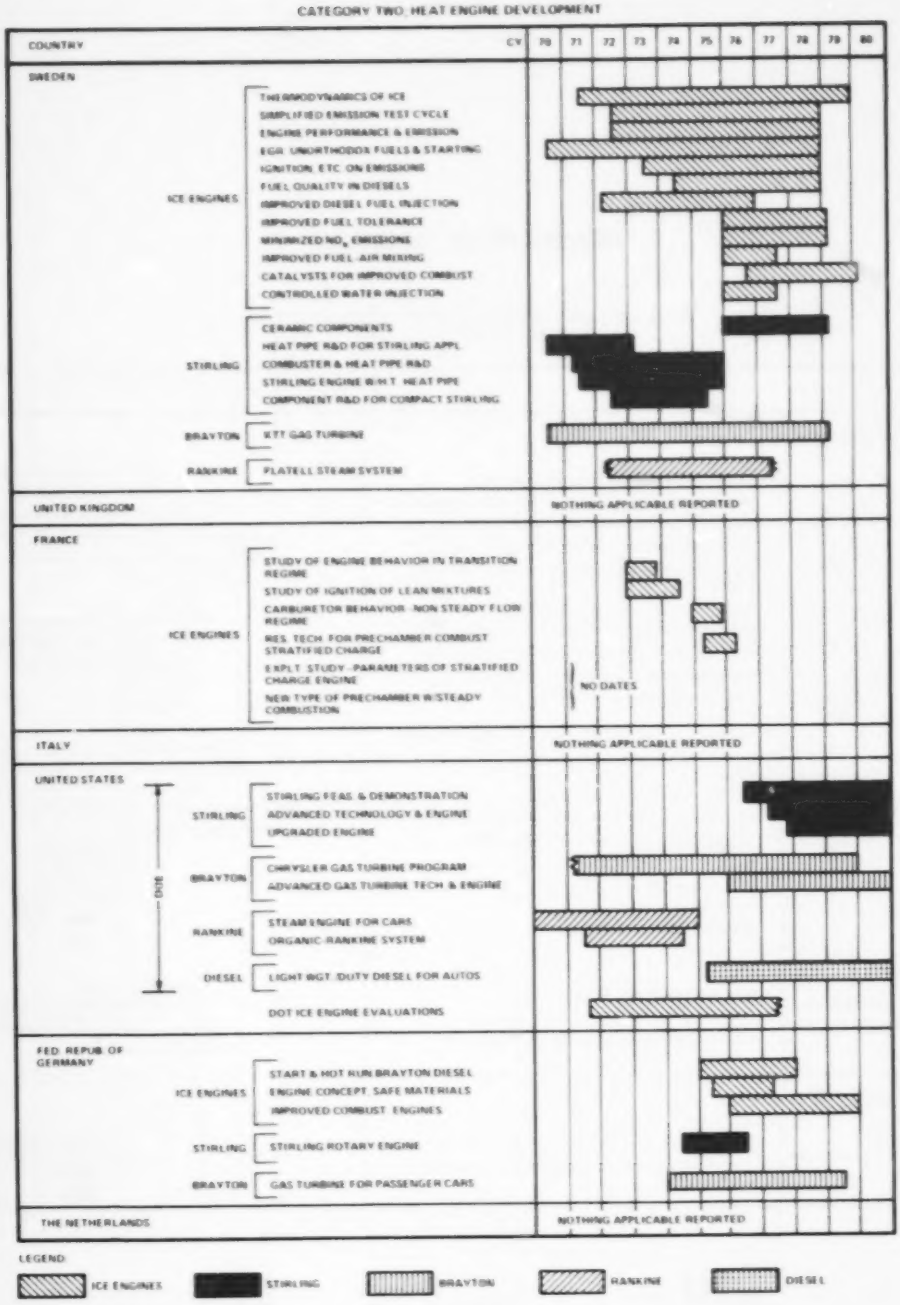


Figure 2

CCMS/LPPSD OVERLAY

CATEGORY THREE; ALTERNATE FUELS, ELECTRIC & HYBRID VEHICLES, ETC. & MATERIALS DEV.

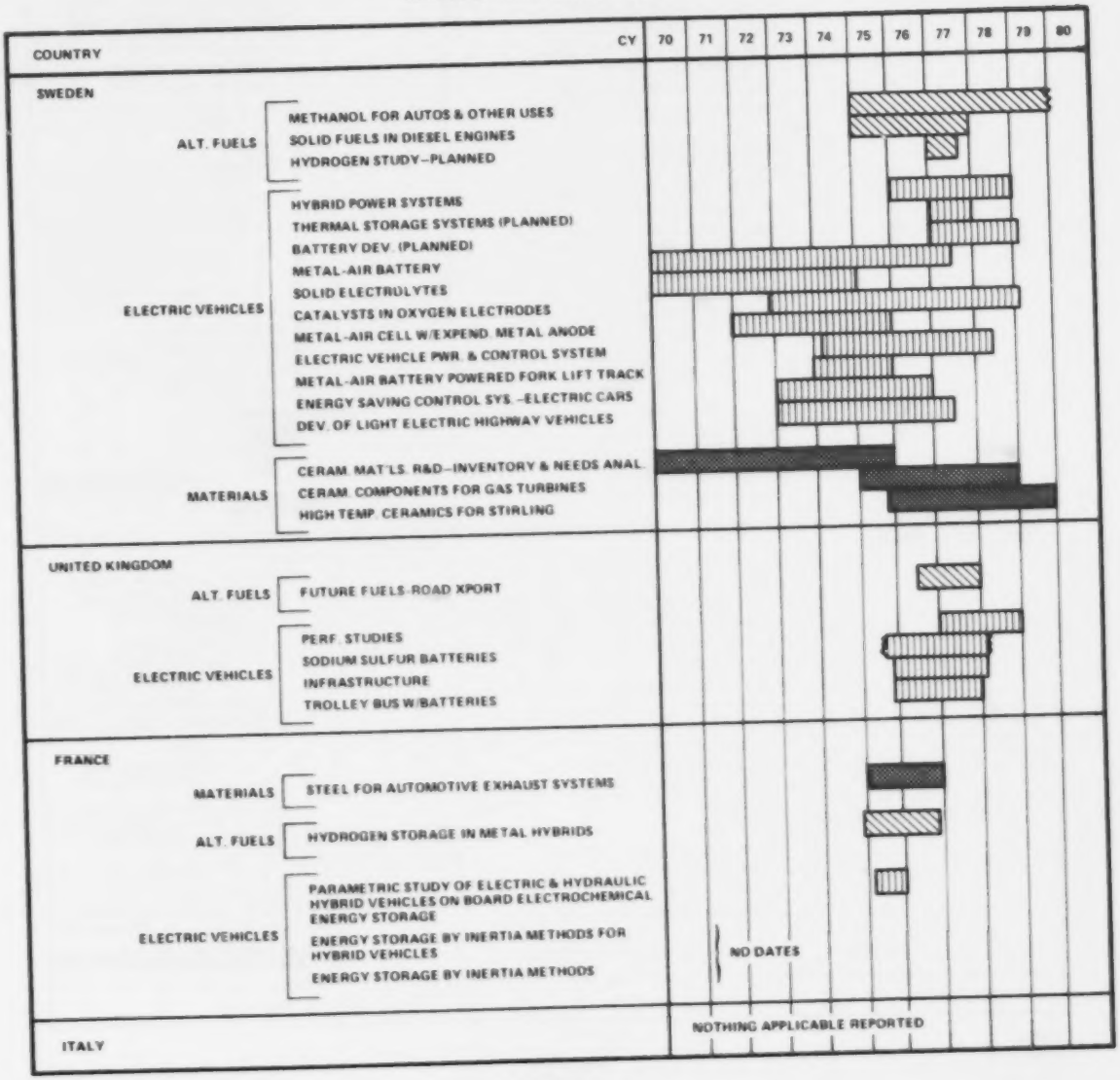


Figure 3

CCMS/LPPSD OVERLAY

CATEGORY THREE; ALTERNATE FUELS, ELECTRIC & HYBRID VEHICLES, ETC. & MATERIALS DEV. (CON'T.)

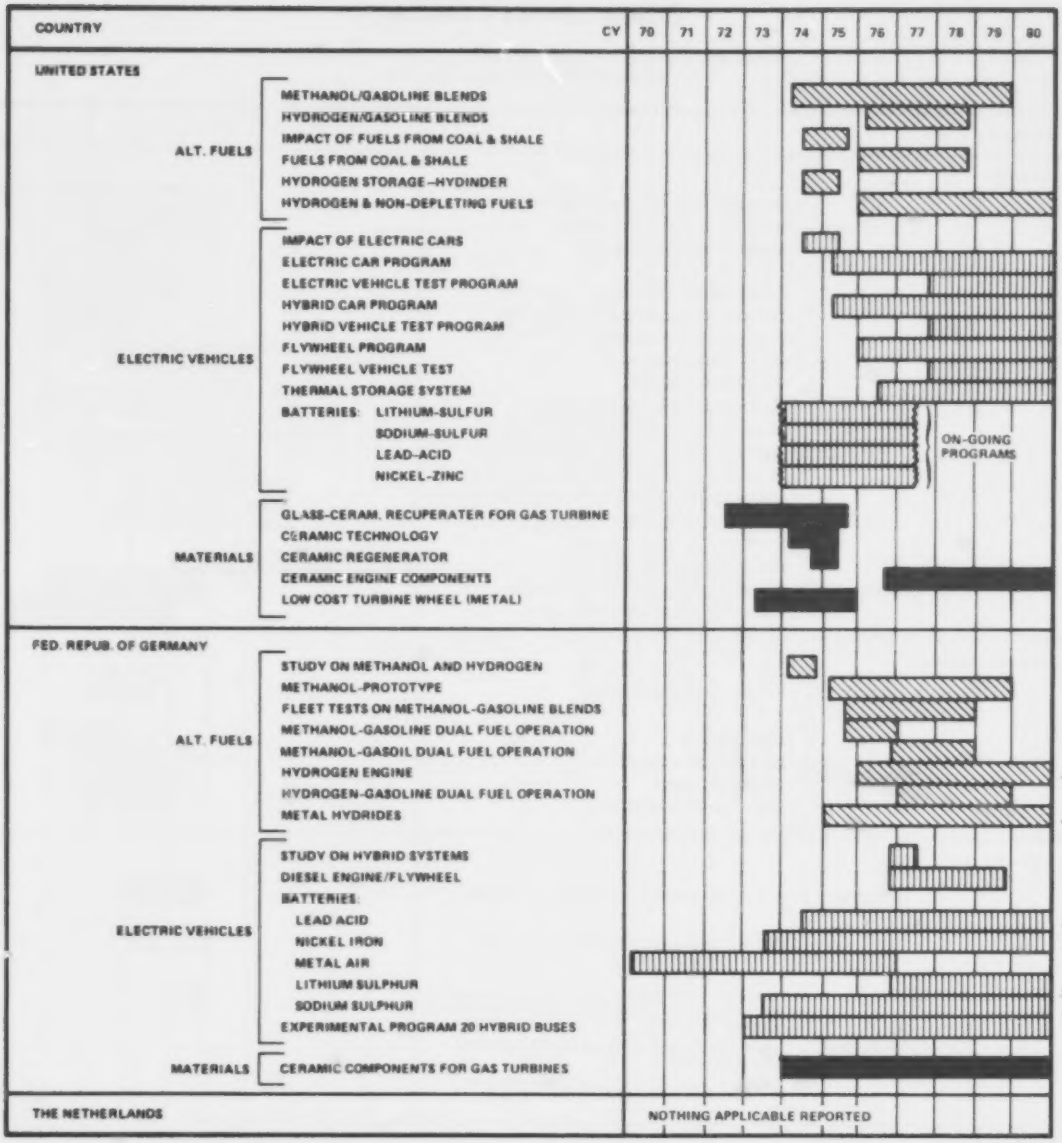


Figure 3 (cont.)

From an APS standpoint, considering the proportion of the programs for conventional vehicles, emissions, and improvements in conventional vehicles, advanced heat engine concepts, alternative fuels, and electrics, it appears to be a fairly well-balanced program.

E. Fourth Symposium, Washington, D.C., April 1977 [4/]

At this time the full impact of the energy crisis and pending legislation had become better recognized among the participating nations; actions and strategies of each country were being implemented. This was apparent from the very large and comprehensive agenda which spanned five days with 14 sessions and 105 presentations. The sessions covered the following technical topics in addition to the usual keynote comments and country-by-country government/industry APS status reports:

- Gas Turbines (2 sessions)
- Diesel Engines
- Stirling and Rankine Engines
- Stratified Charge Engines
- Spark Ignition Improvements
- Automotive Emissions
- Powertrain Components
- Vehicle Improvements
- Alternative Fuels (2 sessions)
- Electric and Hybrid Systems (2 sessions)

Some of the salient elements of these sessions are highlighted here:

1. Gas Turbines

A new gas turbine (Chrysler/DOE upgraded engine) has been under test in the U.S. since August 1976 (Figs. 4 and 5). Several component performance deficiencies were apparent during the first phase of performance testing. A corrective action program to achieve the design goals was initiated. After completion of these design changes and verification of the engine performance, several upgraded engines would be installed in passenger cars for road tests in late 1977. The tests were expected to show fuel economy about 20 percent better than current 8-cylinder conventional engines and exhaust emissions meeting the most stringent standards considered by the U.S. Congress. These emissions levels will be achieved without exhaust aftertreatment. Laboratory tests have already demonstrated this.

Many technical advances are in this engine including use of a new ceramic regenerator or heat exchanger, new aerodynamic designs of rotating machinery, water injection to increase power as needed, combustion processes with very low emissions, gas bearings, and an electronic fuel control.

It is believed that a viable automotive gas turbine needs greater use of low cost, high-temperature ceramic materials. A significant effort, being conducted in parallel to the testing of the new engine, has been initiated to develop ceramic materials and manufacturing processes for use in turbine engines. Both industry and government laboratories are being funded to accelerate this work.

Improved industrial turbines for trucks are evolving (Figs. 6 and 7). Different vehicle engine concepts involving single- and three-shaft configurations are emerging.

2. Stirling Engine

The Ford/Philips Stirling engine (Fig. 8) program was in the procurement stage. A multi-staged hardware development program was planned to demonstrate an improved Stirling engine by 1983. This work would aim at a 30-percent improvement in fuel economy, competitive performance and production cost, and very low emissions compared to the conventional engine.

Figure 4

New, smaller, upgraded turbine engine has been designed for installation and testing in the compact Dodge Aspen

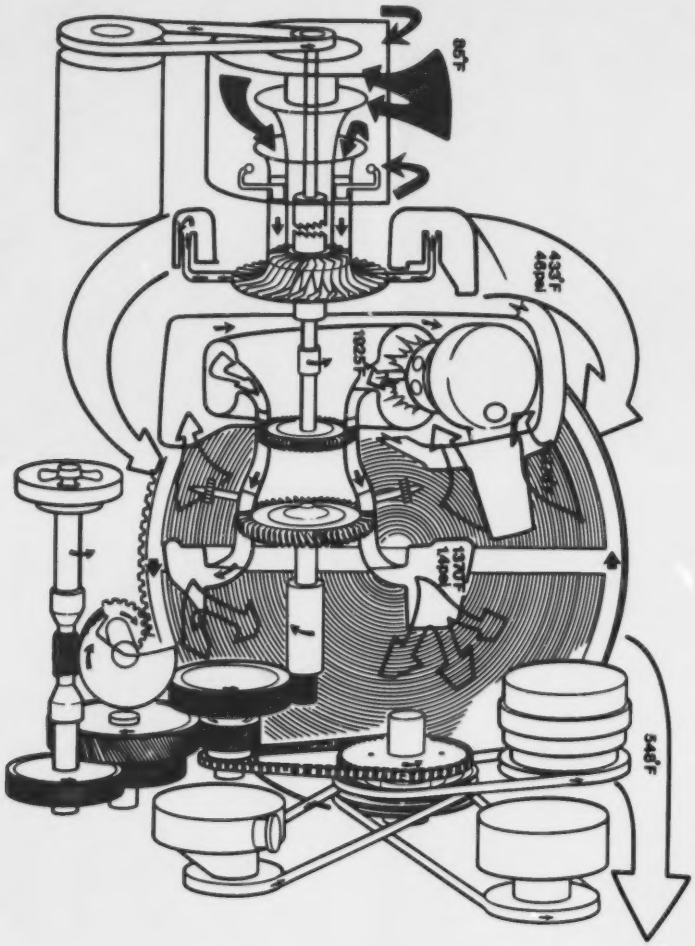


Figure 5

Schematic diagram of Chrysler Corporation's Upgraded Gas Turbine Engine, which is being developed with the U.S. Department of Energy. The illustration shows air flow and various temperatures at full power from incoming fresh air to exhaust. Air enters the intake and is drawn into the compressor where its pressure is increased four times. The air is preheated as it passes through the regenerator core (rotating heat-exchanger). It passes into the burner into which fuel is sprayed by the fuel nozzle and burned at a temperature of 1,925°F. The hot gases pass through the compressor drive turbine and then through the power turbine which delivers power to the rear wheels. The gases are exhausted through the rear half of the regenerator losing most of their remaining heat before being discharged through the exhaust duct. The regenerator core rotates the heat recovered from the exhaust to heat the incoming air, thus improving fuel economy and reducing exhaust temperature.

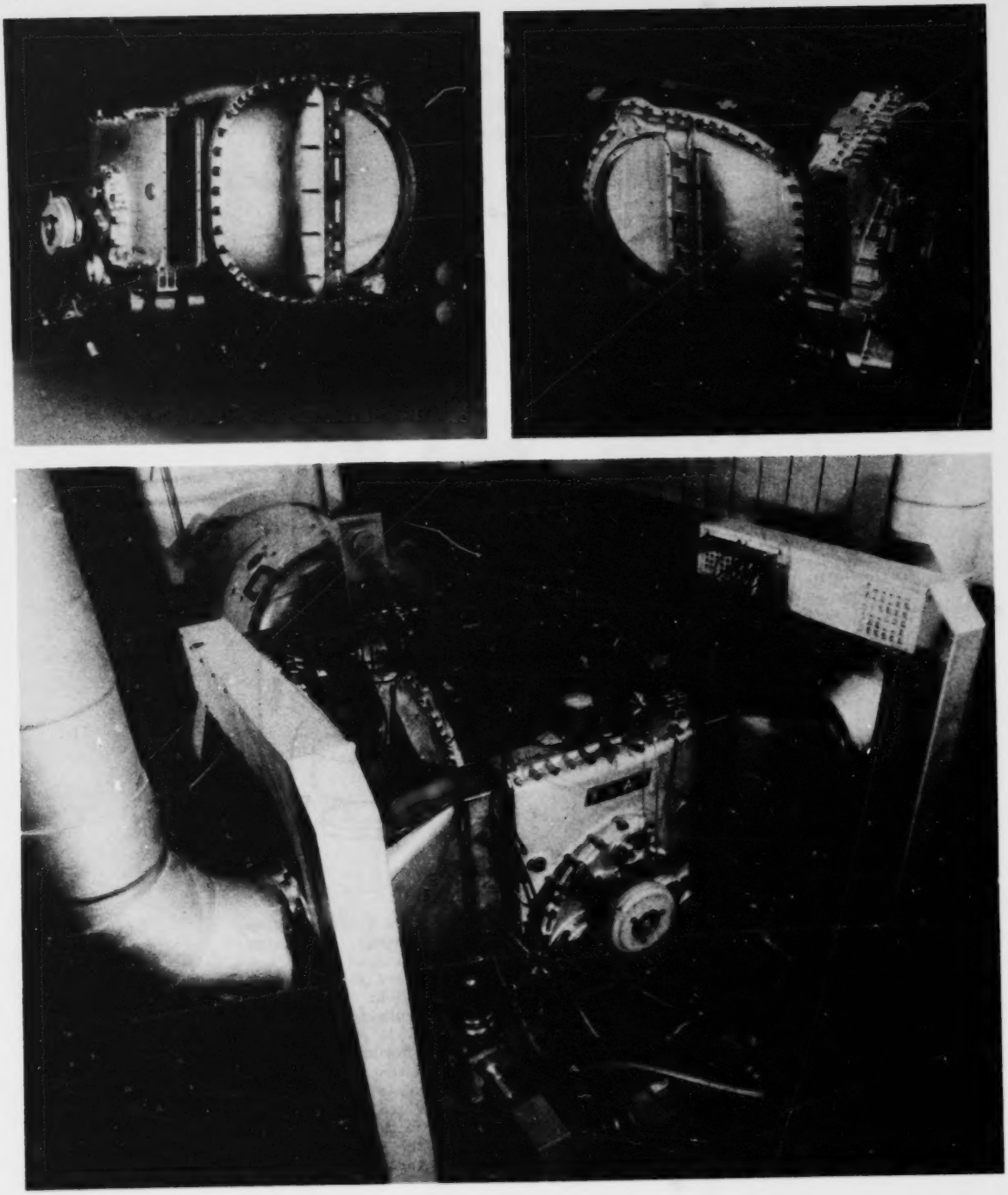


Figure 6

Fiat gas turbine for heavy-duty haulage. Bench tests.

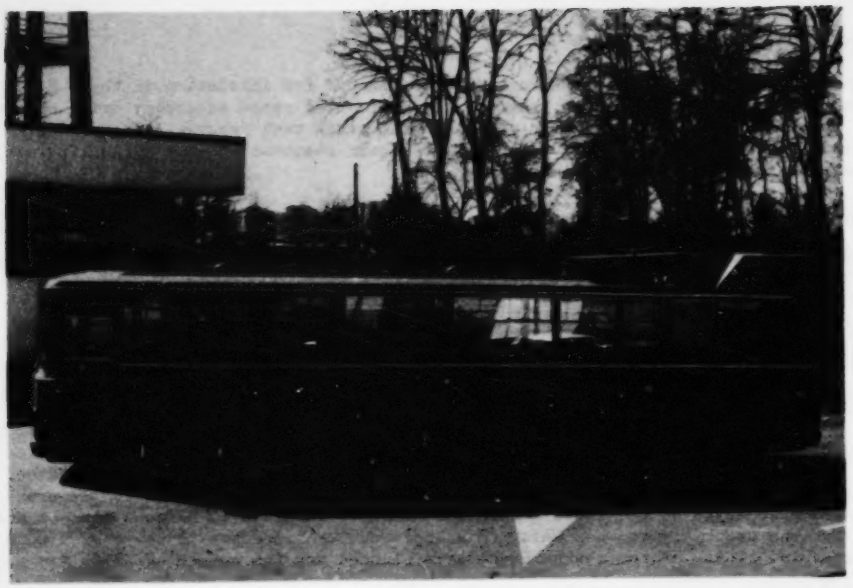


Figure 7

Fiat experimental bus powered by a gas turbine

Figure 8

Only minor modifications are necessary to package the Ford-Philips Stirling engine in a 1975 Torino. Cooling slots have been inserted in the front bumper and hood and a larger radiator is employed. The engine mates to a conventional Ford three-speed automatic transmission. The Stirling is considered a leading alternate-engine candidate because of its potential for low emission and noise levels, improved fuel economy, smoothness of operation, and ability to operate on a variety of fuels.

3. Fleet Demonstration

A number of fleet demonstration programs were planned for initiation in the U.S. in 1977. These included the gas turbine city bus program, the controlled speed accessory drive automobile program, and possibly an advanced compound diesel engine truck test program. These programs were being initiated to evaluate fuel economy improvements, user response, in-use durability and reliability characteristics, and ease of maintenance.

4. Accessory Drive

A new accessory drive, developed for the automotive application showed 6 to 12-percent improvement in fuel economy based on road testing.

5. Continuously Variable Transmission

A continuously variable transmission was developed for passenger cars. The first generation of this design was demonstrated to achieve a 23-percent improvement in fuel economy in a 2,500-mile run across the United States.

6. Waste Heat Recovery

A waste heat recovery system was developed to use the heat normally wasted in truck diesel exhaust. Dynamometer tests of the first generation hardware showed a 13-percent improvement in fuel economy for the truck engine when using this approach. Refinements in the design were underway and on schedule. Tests of the new hardware were planned for the summer of 1977.

7. Nonpetroleum-Base Fuel

Work on how to use nonpetroleum-base fuels in automobiles was continuing in government and industry laboratories in the U.S. and at Volkswagen in the FRG. Alcohols, liquid fuels from coal and shale, and hydrogen have been included in the U.S. program. Reported activities concentrated on alcohol fuels where attention is being focused on comparative evaluation of problem-solving alternatives. The program has been under review with the expectation of expansion into such areas as finding better ways to use petroleum fuels and ways to use existing fuels technologies under emergency conditions.

8. Electric Vehicles

The work on electric and hybrid automobiles is being accelerated in the U.S. by virtue of Federal legislation enacted in September 1976 which called for large-scale demonstration of electric vehicles as well as increased efforts to develop vehicles, new batteries and power systems components. Preliminary designs for two future electric vehicles were completed and contracts were being negotiated to complete their development within the next two years. Work was also underway on a variety of supporting studies aimed at assessing the potential of various advanced electric vehicle concepts, identifying institutional barriers and market incentives for electric and hybrid vehicles, and assessing regenerative braking for these types of propulsion systems.

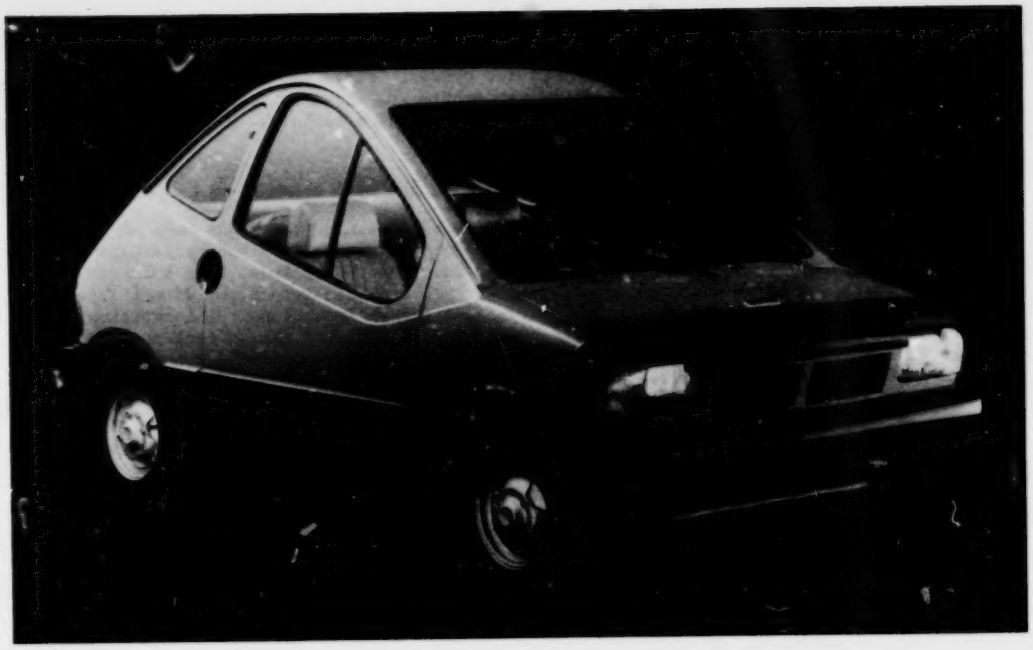
Finally, the first phase of the demonstration program (involving as many as 2,500 vehicles) is scheduled to begin in 1978. Assessments of the current state-of-the-art and the preparation of performance specifications were being conducted in preparation for the demonstration.

Considerable work on electric and hybrid vehicle systems was also in progress in all of the participating countries (Fig. 9).

9. Diesel Engines

The diesel engine with very high fuel economy is emerging as a significant competitor to the conventional spark ignition gasoline engine. Volkswagen has planned American production of a diesel-engined Rabbit. General Motors is developing a passenger car for Oldsmobile. Other companies also have diesel passenger car programs. European manufacturers continued their work in this direction.

Principal drawbacks of the diesel are higher cost, noise and vibration, difficult cold starting, odor, and sluggish performance. If emission legislation requires less than 1.0 g/mi NOx on the U.S. Federal driving cycle, the diesel engine will have difficulty meeting this standard.



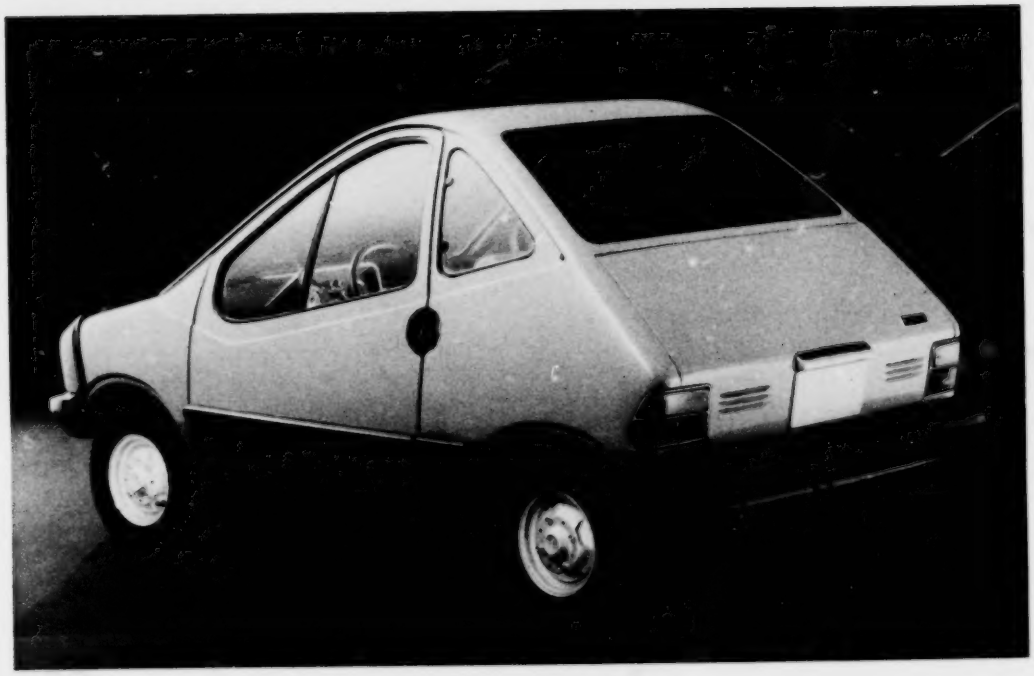


Figure 9

Fiat electric city car prototype

Work on an "adiabatic" (uncooled) diesel engine for heavy duty truck application was revealed by Cummins Engine Company. It is turbo-compounded (excess energy from the turbocharger is returned to the diesel engine crankshaft) and uses ceramic piston crowns, liners and other critical high temperature components, but no radiator, fan or cooling system. A specific fuel consumption of 0.28 lb/BHP-hour is expected by early 1979. This could constitute a technical breakthrough in the piston engine field.

10. Stratified Charge Engines and Improved Spark Ignition Engines

Prime emphasis in Europe and with most of the automobile manufacturers has been on improvements to present engines to meet fuel economy and low emission targets. This course perhaps represented the lowest cost, near-term, but interim solution. Such avenues included lean burn concepts, fuel-air ratio controls, on-board microprocessors (computers), manifold injection, direct injection, divided combustion chambers, improved catalysts, and exhaust gas recirculation. All represent increases in cost and complexity. Many of the above represent stratified charge concepts and perhaps solutions to the fuel economy-emissions problems. Durability and acceptable maintenance cost are factors which must ultimately be demonstrated in the field.

11. Rankine Engines

Work on the DOE rankine cycle steam engine is virtually complete. The original objective was to demonstrate a steam engine in a vehicle which met the most stringent standards of the Clean Air Act without resorting to exhaust treatment. The first generation engine on its original Dodge chassis achieved emission levels about 1/3 less than the HC, CO, and NOx standards when run over the U.S. Federal driving cycle.

Further development of this system is not being pursued by DOE mainly because significant improvements in fuel economy are not foreseen. Rankine system competitors are receiving funding because they offer the potential of both very good fuel economy and very low emissions. The rankine cycle system appears to have the cleanest untreated exhaust emissions of any engine presently available.

APPARENT TRENDS AND OBSERVATIONS

A. Automotive Propulsion Systems

Each nation and each manufacturer view the shifting requirements, current state of technological development, trends in development, and the markets from a somewhat different perspective. Based on the different locations, different facilities, different interests, different strengths, and different weaknesses, each manufacturer develops his own strategy and approach. The present general highway transportation requirements for high fuel economy, low emissions, nonpetroleum-based fuels, and the incentives to supply a profitable product to growing, but very competitive, international markets have resulted in greatly increased R&D activities on a wide variety of systems. Many options and approaches have been explored and dropped.

There is no apparent winner or winners, but there are a number of promising approaches or directions of development. Much depends on details of legislation, the actual availability and prices of fuels, the results of the developments, and the verdict of the marketplace.

The near-term avenues involve the improvement of conventional spark ignition engines and vehicles which include:

- lean-burn combustion systems
- better charge distribution between cylinders
- elimination of inlet throttling
- manifold injection and direct fuel injection systems
- use of microprocessors (on-board, low-cost mini-computers) to control fuel-air ratio and spark and/or injection timing
- divided combustion chambers
- improved catalysts and aftertreatment systems (aimed at lower cost, longer life, less fuel economy penalty)
- stratified charge engines (perhaps a little longer term)
- optimized accessory drives and accessories
- optimized transmissions with controlled shift points to minimize fuel consumption
- vehicle improvements that are dominated by weight reduction measures without sacrificing safety. Other increments include higher tire pressures, noise reduction, and better aerodynamic design.
- introduction of the diesel engine in passenger cars. Several models are on the market or expected shortly. High fuel economy is the key incentive. Problems involve high first cost, difficulty in getting NOx levels below 1 g/mi, noise and odor.

Longer-term efforts are directed at:

- gas turbines
- Stirling engines
- turbocompound engines, particularly in the heavy duty area, which appear to offer the ultimate in fuel economy
- supporting technology toward high temperature materials (such as ceramics), lower cost manufacturing processes, and transmissions
- electric and hybrid systems (considered long range, but much effort is devoted to this direction because of low emissions and nonpetroleum-based fuel considerations)

- in the alternate fuels area, methanol and methanol-gasoline blends seem to be the nearest-term alternative, but only on an emergency basis. The virtues and advantages of hydrogen continue to attract research effort as a long-term alternative.

B. Rationale and Results of International Symposia, Coordination, and Cooperation

Observations and discussions during the symposia revealed the following:

- The technical problems of automotive propulsion systems and their implications have brought concerned government leaders, key industrial representatives, leading scientists, and engineers together from all over the world on a common ground discussing common problems, similarities and differences, and approaches to solutions.

- Many direct personal contacts have developed between key people in industrial organizations and the various governments. This establishes a vital two-way channel of communication. Ultimately this means a better mutual understanding of each other's problems and objectives, and faster, smoother progress toward the common objectives.

- The pattern of government-supported or cost-shared research and development activities now appears to be widely established in the participating countries.

- Efforts to coordinate, to avoid duplication and overlap, and to share the results particularly in the more fundamental research areas, are apparent. Notably, such areas include: ceramic materials development and application, fundamental combustion work, and electric and hybrid systems.

- The time and large investment necessary to develop and implement changes or new propulsion systems is now more broadly appreciated.

- Significant and rapid changes involving relatively high business risks are very expensive and beyond the financial resources of even the largest industrial companies.

- The governments involved recognize the need to accelerate the development of solutions to the problems; also recognized is the need to provide support or share the expense.

- Needless duplication of effort, expense and facilities needs to be avoided.

- The autonomy and proprietary elements of individual companies should be preserved.

- Much needs to be done to improve and expand international cooperative activities in the transportation area with the intent of reducing the energy consumption of the transportation sector while still meeting the needs of the individual citizen requiring transportation services.

- Because of the many commercial considerations in this area, government-to-government relationships and cooperation may be more difficult to implement, at least initially. Company-to-company or government-company arrangements may be more expeditious and versatile. Many such arrangements are in evidence such as Ford/Philips, U.S. Department of Transportation/Volkswagen, and Volkswagen/Princeton University/Sandia Laboratories.

- There is no unanimity of opinion about the proper government role in transportation research, development, and demonstration. It is generally apparent that government participation should not inhibit the industry and perhaps is best aimed at longer-term development and problems which affect the community such as noise, emissions, odor, and fuel economy. It is obvious that this is an area which is evolving; both government and industry are groping for the right balance and appropriate means for implementation.

C. Areas for Future Cooperative Effort

As a result of the ongoing communication established through the international symposia, numerous suggestions of areas, subjects or problems for future bilateral or multilateral projects have emerged. Emphasis will be on a few carefully selected, high quality technology development projects. Areas for initial exploration might include the following:

1. Power Systems and Components

Cooperation:

- coordination of national programs to be complementary and minimize gaps in technical efforts
- technical data exchanges
- hardware exchanges

Technical Areas:

- combustion theory and technology
- advanced heat engine concepts and designs
- transmissions

2. High Temperature Materials

Cooperation:

- coordination of national programs
- technical data exchanges
- hardware exchanges

Technical Areas:

- ceramic materials
- advanced turbine concepts and designs
- Stirling engines
- diesel engines

3. Alternative Fuels

Cooperation:

- technical information exchange
- hardware exchanges

Technical Areas:

- fuels characterization
- production techniques
- economic analyses
- engine design requirements
- multi-fuel engines

4. Electric and Hybrid Vehicle Systems

Cooperation:

- coordination of national programs
- technical information exchanges
- component and/or vehicle exchanges

Technical Areas:

- motors and controllers
- vehicle components
- vehicle designs
- batteries
- service systems and infrastructure

Preliminary informal discussions of these subjects with representatives from the United States, United Kingdom, Germany, Italy, Sweden, Canada, France, The Netherlands, and Brazil indicate strong interest.

D. Administration

Because of the extended scope of technical coverage now enveloped by the program and symposia and the much broader international interest, consideration will be given to the proper agency or medium to foster and coordinate the extended international activities on Automotive Propulsion Systems. The intent and purpose of the original NATO/CCMS LPPSD Pilot Study has been served. Further development of this activity might best be continued within a broader more comprehensive framework.

RESOLUTIONS AND RECOMMENDATIONS

Based on the technical content of the symposia, numerous meetings and discussions with key people, and the observed trends, three resolutions regarding national programs for automotive energy research and development and four recommendations establishing a framework for fostering continued international cooperation were derived from the activities of the Pilot Study.

A. Resolutions

In recognition of the important energy and environmental implications of the transportation sector, be it resolved that member nations will:

1. Encourage continued and increased emphasis on national research and development programs aimed at development of new and improved energy-efficient and environmentally acceptable engine systems, electric powered vehicles, systems to minimize and/or control emissions (including noise) from combustion engines, and alternative fuels.

2. Review budgets and resource allocations with a view towards ensuring that sufficient funds are made available for the timely development of energy-efficient and environmentally acceptable automotive propulsion systems.

3. Encourage appropriate national agencies to participate to the fullest extent practicable with colleague agencies, industries, and research communities in developing and implementing long-term national research objectives for the development of energy-efficient and environmentally acceptable automotive propulsion systems.

B. Recommendations

Recognizing that international cooperative activities can be of direct assistance in meeting national program goals, it is recommended that member nations:

1. Support and encourage the initiation of long-term cooperative activities, involving both governmental and private sectors, oriented toward development of energy-efficient, environmentally acceptable automotive propulsion systems including emissions control systems and alternative fuels. This collaboration may extend beyond the information exchanges accomplished through any periodic symposia and should seek to establish collaboration in the form of coordinated research and development programs, exchange of equipment and test results, interchange of personnel, or joint support of specific projects. The collaboration may be carried out within existing international organizations, or through ad hoc multilateral or bilateral agreements.

2. Use the following procedures to initiate specific cooperative projects:

   - Participating nations will identify areas of mutual interest.

   - Participating nations will nominate specific key technical specialists in the areas selected for cooperation.

   - The specialists from each nation electing to participate in a selected area will meet to define and agree on project objectives and a reasonable scope of work to be accomplished which will provide a basis for monitoring and judging project progress.

   - Participating nations will develop formal agreements for pursuit of these objectives on a cooperative basis. Agreements may be either bi- or multilateral in nature, and may call for the involvement of existing international organizations depending on the nature of the project under consideration and the views of interested countries.

   - Until such time as a lead country is designated for a specific project, the United States will assume responsibility for scheduling and organizing meetings of experts.

3. Continue to cooperate in the exchange of technical and economic information through periodic reviews of significant developments resulting from the cooperative projects program, or, if deemed useful by participants (determined through a survey conducted by the United States), the exchange of information about national programs in periodic reviews utilizing international symposia as initiated under the Pilot Study. Participation and sponsorship of the reviews will be open to all interested nations. Sponsorship of such symposia will rotate.

4. Facilitate continued international exchange of information and cooperation by:

   Updating, at least annually, Appendix E of this Final Report, which tabulates the organization, principal areas of technical activity, and the complete mailing address of the organization and key individuals or points of contact in the selected areas under the cooperative projects program. The United States will serve as the focal point for collecting, collating, and distributing updated information.

   Designating a single official (or agency) to be responsible for the coordination of information for followup activities of the Pilot Study.

REFERENCES

1. Proceedings of the First "Symposium on Low Pollution Power Systems Development," October 14-19, 1973, Ann Arbor, Michigan, USA, for the NATO Committee on the Challenges of Modern Society, CCMS Report N.32.

2. Proceedings of the Second "Symposium on Low Pollution Power Systems Development," November 4-8, 1974, Düsseldorf, Federal Republic of Germany, for the NATO Committee on the Challenges of Modern Society, CCMS Report N.39.

3. Proceedings of the Third "Symposium on Low Pollution Power Systems Development," December 2-3, 1975, Rome, Italy, for the NATO Committee on the Challenges of Modern Society, CCMS Report N.48.

4. Proceedings of the Fourth "Symposium on Automotive Propulsion Systems," April 18-22, 1977, Washington, D.C., USA, for the NATO Committee on the Challenges of Modern Society, CCMS Report N.61.

APPENDIX A

LPPSD MEMORANDUM OF UNDERSTANDING

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MEMORANDUM OF UNDERSTANDING ON THE DEVELOPMENT
OF LOW POLLUTION POWER SYSTEMS FOR MOTOR VEHICLES

1. This multilateral Memorandum of Understanding is concluded, following an exchange of views which took place within the Committee on the Challenges of Modern Society of the North Atlantic Council, between the following agencies:

a. The Federal Ministry of the Interior of the Federal Republic of Germany; 1/

b. The Institute of Transport Research of France;

c. The Ministry of Transport of Italy;

d. The Ministry of Transport and Waterways of The Netherlands;

e. The Department of the Environment of the United Kingdom;

f. The Environmental Protection Agency of the United States of America. 2/

The aim of this Memorandum is to encourage the development and testing of low pollution power systems for motor vehicles (which encompass new types of engines or advanced control systems for the internal combustion engine) in the interest of the health and well being of our peoples. The signatories to this Memorandum of Understanding will cooperate freely with each other and with other countries and international organizations with similar goals and programs so as to ensure that the total resources available internationally for developing and bringing into use vehicles with low pollution power systems are deployed to the best advantage.

2. There are, in the countries of the signatories to this Memorandum of Understanding, governmental and/or industrially sponsored programs which collectively form a broad based attack on a challenging technological problem facing our society. Believing that international cooperation in the field of motor vehicle pollution control will prove fruitful for all signatories, the signatories will undertake a comprehensive exchange of knowledge gained about the design, the technical characteristics and the performance of low pollution power systems in the course of the conduct and monitoring of development activities within their respective countries, insofar as such information is at their disposal for publication, in as timely and detailed a manner as is possible under their respective statutes. Additionally, they will participate in technical symposia, expected to be held at least annually, for the review of research and development programs, discussions and exchange of information and ideas.

3. When two or more parties to this Memorandum of Understanding wish to develop more specific relationships on subprograms or projects within the fields of this Memorandum of Understanding, details of any agreement, arrangement or accord between them may be annexed to this Memorandum of Understanding.

4. The procedures to be used to implement this cooperative program will be developed among the signatories with the Environmental Protection Agency of the United States of America acting as the coordinating agency. 2/

5. This Memorandum of Understanding is open to subsequent participation by the relevant governmental department or agency of other countries subject to the agreement of existing signatories.

6. This Memorandum of Understanding shall come into operation for each signatory on the date of its signature thereof and will remain in operation indefinitely in respect of all signatories which have not notified the termination of their participation by 30 days notice in writing.

1/ Responsibility for coordination of LPPSD activities in the Federal Republic of Germany was transferred to the Federal Ministry for Research and Technology in January 1977.

2/ Responsibility for coordination of LPPSD activities in the United States was transferred to the Energy Research and Development Administration in February 1976, and subsequently, through reorganization, to the Department of Energy in October 1977.

DONE NOVEMBER 14, 1972, AT BRUSSELS:

Robert W. Fri
UNITED STATES OF AMERICA

M. M. Frybourg
FRANCE

Günter Hartkopf
FEDERAL REPUBLIC OF GERMANY

C. Calenda
ITALY

Johan G. Kuiperbak
THE NETHERLANDS

Alan Cottrell
UNITED KINGDOM

APPENDIX B

ANNEX TO MEMORANDUM OF UNDERSTANDING

ANNEX TO MEMORANDUM OF UNDERSTANDING ON LOW POLLUTION POWER SYSTEMS DEVELOPMENT CONCERNING EXCHANGE OF TECHNICAL INFORMATION

I. On November 14, 1972, a Memorandum of Understanding concerning Low Pollution Power Systems Development (LPPSD) was concluded between the appropriate agencies of the following nations: the Federal Republic of Germany, France, Italy, The Netherlands, the United Kingdom, and the United States, hereafter referred to as the "participants" to this agreement. This Memorandum included provisions for technical symposia, technical information exchange, and collaborative projects. This annex is designed to provide a timely, orderly, and efficient means of exchanging technical information on research, development, and testing of low polluting power systems among all of the participants in the Memorandum, so that each participant might keep abreast of parallel LPPSD developments in other countries party to the Memorandum.

II. Technical information on LPPSD shall be made available on a voluntary basis as described below:

(a) Any information made available under this annex will be made available simultaneously to all participants in the Memorandum by direct transmission to a contact to be named for each participant.

(b) Information exchanged may include (to the extent that the laws of the respective participants allow), but not be limited to:

1. General information of each participant's current LPPSD programmes, including their objectives, results, funding levels, etc.

2. Interim reports on LPPSD progress.

3. Final project reports.

4. Results of bilateral or multilateral collaborative projects undertaken under the Memorandum.

5. Reports issued as a result of technical symposia. In this regard the report on the annual LPPSD Conference will constitute the annual report to the Committee on the Challenges of Modern Society on the progress made in LPPSD.

6. Other technical information likely to be of interest to the participants.

(c) Each participating state may provide information in its native language only.

(d) Proprietary information identified as such by the source shall be released only to those participants or persons specified by the source, or to whom release is subsequently authorized by the original source.

III. Any participant may terminate his participation in the program envisaged in this annex at any time by informing all remaining participants of his intention to do so.

IV. Changes may be made to this annex at any time subject to the approval by all participants.

V. This annex takes effect from the date of its signing by authorized representatives of all participants, and shall remain in operation indefinitely unless terminated with the consent of the participants.

DONE OCTOBER 19, 1973, AT ANN ARBOR, MICHIGAN:

John J. Brogan
UNITED STATES OF AMERICA

(Signed by France on separate document)

FRANCE

Dietrich Hartmann
FEDERAL REPUBLIC OF GERMANY

Vincenzo Opportuno
ITALY

Johan G. Kuiperbak
THE NETHERLANDS

George Donald
UNITED KINGDOM

APPENDIX C

NATIONAL REPRESENTATIVES FOR EACH SYMPOSIUM

NATIONAL REPRESENTATIVES FOR EACH SYMPOSIUM

Following are the Heads of the National Delegations to each of the four NATO/CCMS Symposia on Automotive Propulsion Systems:

	SYMPOSIA			
	1st 1973	2nd 1974	3rd 1975	4th 1977
CANADA (Observer)				
Mr. A. C. Gullon Air Pollution Directorate Environmental Protection Service Ottawa		X	X	X
FRANCE				
Mr. Claude Lamure Centre d'evaluation et recherche des nuisances Institut des Recherche Transports Bron Cedex	X		X	X
Mr. Gauvin Ministère de l'Equipement Paris		X		
FEDERAL REPUBLIC OF GERMANY				
Dr. Dietrich Hartmann Umweltbundesamt Berlin	X			
Mr. Hans-Ludwig Dreissagacker Bundesministerium des Innern Bonn-Bad Godesberg		X		
Dr. Dietmar Frenzel Bundesministerium für Forschung und Technologie Bonn-Bad Godesberg		X		
Mr. Axel Schönfeld Umweltbundesamt Berlin			X	
Dr. Jürgen Bandel Bundesministerium für Forschung und Technologie Bonn-Bad Godesberg				X
ITALY				
Mr. Vincenzo Opportuno Motorizzazione Civile e Trasporti in Concessione Ministero dei Trasporti Rome	X	X		
Mr. Augusto Sirignano Motorizzazione Civile e Trasporti in Concessione Ministero dei Trasporti Rome			X	

	SYMPOSIA			
	1st 1973	2nd 1974	3rd 1975	4th 1977
ITALY (continued)				
Mr. Renzo Strampelli Motorizzazione Civile e Trasporti in Concessione Ministero dei Trasporti Rome				X
THE NETHERLANDS				
Mr. Johan G. Kuiperbak Department of Road Transport Ministry of Transport and Public Works The Hague	X	X		X
Mr. Gerardus J. M. Meekel Department of Road Transport Ministry of Transport and Public Works The Hague			X	
SWEDEN (Observer)				
Mr. Olle Ljungström National Swedish Board for Technical Development Stockholm	X	X		
Mr. Stig G. Carlqvist, Consultant National Swedish Board for Technical Development Stockholm				X
UNITED KINGDOM				
Mr. George Donald Department of the Environment London	X	X	X	
Mr. Ronald E. Wilsdon Department of Industry London				X
UNITED STATES				
Mr. John J. Brogan Division of Transportation Energy Conservation Department of Energy Washington, D. C.	X		X	X
Mr. Roger Strelow Office of Air and Waste Management Environmental Protection Agency Washington, D. C.		X		

APPENDIX D

ORGANIZATIONS PARTICIPATING IN SYMPOSIA

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ORGANIZATIONS PARTICIPATING IN SYMPOSIA

Aerojet Liquid Rocket Company, USA

Aerospace Corporation, USA

Alfa Romeo, I

American Garelli East, USA

Army Materials and Mechanics Research Center, USA

Army Tank Automotive Research and Development Command, USA

Arthur D. Little, Inc., USA

ASL Engineering, Inc., USA

Audi NSU Auto Union AG, D

Bartlesville Energy Research Center, USA

Billings Energy Corp., USA

Booz, Allen and Hamilton, Inc., USA

British Embassy, USA

British Leyland UK, Ltd., GB

Brookhaven National Laboratory, USA

Brown, Boveri and Cie AG, D

Bundesministerium des Innern, D

Bundesministerium für Forschung und Technologie, D

Bundesministerium für Verkehr, D

Bundesministerium für Wirtschaft, D

California State Assembly, USA

Centre de Recherche de l'Institut de Recherche des Transports, F

Chalmers Tekniska Högskola, S

Chrysler Corporation, USA

Citroen, USA

Commission of the European Communities, B

Consiglio Nazionale delle Ricerche, I

Corning Glass Works, USA

Council on Environmental Quality, USA

Cummins Engine Company, USA

Curtiss-Wright Corp., USA

Daigh Automotive Engineering, Inc., USA

Daimler-Benz AG, D

D-Cycle Power Systems, USA

Department of Commerce, USA

Department of Energy, USA

Department of the Environment, GB

Department of Industry, GB

Department of Industry, Trade and Commerce, C

Department of Transportation, USA

Deutsche Vergaser GmbH & Co. KG, D

Dornier System GmbH, D

Energy, Mines and Resources, C

Environmental Protection Agency, USA

Environmental Protection Service, C

ESB, Inc., USA

Escher Technology Associates, USA

Exxon Research and Engineering Company, USA

Fiat Motor Company, I

Ford Motor Company, USA

Fuel Injection Development Corp., USA

Fuji Electric Company, Ltd., J

Garrett-AiResearch Manufacturing Company, USA

General Electric Company, USA

General Motors Corporation, USA

General Motors Detroit Diesel Allison Division, USA

General Research Corporation, USA

Gesellschaft für Elektrischen Strassenverkehr mbH, D

Global Scientific Engineering, Inc., USA

Harker Industries, Inc., USA

Honda Motor Company, Ltd., J

Honda R & D Company, Ltd., J

Institut Francais du Petrole, F

Institut für Motorenbau, D

Institut voor Wegtransportmiddelen TNO, NL

Institute of Gas Technology, USA

Japan Automobile Research Institute, Inc., J

Jay Carter Enterprises, USA

Jet Propulsion Laboratories, USA

Johnson Matthey Chemicals, Ltd., GB

Klöckner-Humboldt-Deutz AG, D

Lawrence Livermore Laboratory, USA

Le Moteur Moderne, F

Lear Motors Company, USA

Maschinenfabrik Augsburg-Nürnberg AG, D

Mechanical Technology, Inc., USA

Ministère de l'Equipement, F

Ministère de l'Industrie du Commerce et de l'Artisanat, F

Ministère Qualite de la Vie, F

Ministerie van Volksgezondheid en Milieuhygiene, NL

Ministerium für Arbeit, Gesundheit und Soziales des Landes Nordrhein-Westfalen, D

Ministero Trasporti, I

Ministry of Transport and Public Works, NL

Mueller and Associates, Inc., USA

National Aeronautics and Space Administration, USA

National Research Council, C

Netherlands, Embassy of The, USA

Nippon Soken, Inc., J

Nissan Motor Company, Ltd., J

North Atlantic Treaty Organization, B

Orshansky Transmission Corp., USA

Owens-Illinois, USA

Perkins Engine Company, GB

Philips (N.V.) Research Laboratories, NL

Piaggio & Co., S.p.A., I

Porsche AG, D

Postal Service, USA

Pratt & Whitney Aircraft, USA

Renault, F

Ricardo & Co. Engineers, Ltd., GB

Robert Bosch GmbH, D

Saab-Scania, S

Scientific Energy Systems, Corp., USA

Shell International Petroleum, GB

Siemens AG, D

Solar Division of International Harvester, USA

Southwest Research Institute, USA

Stanford University, USA

Stevens Institute of Technology, USA

Sweden, Embassy of, USA

Swedish Board for Technical Development, S

Technische Hochschule Aachen, D

Technische Hochschule Darmstadt, D

Technische Universität Braunschweig, D

Technische Universität Hannover, D

Technische Universität München, D

Technische Universität Stuttgart, D

Technischer Überwachungs-Verein Rheinland e.V., D

Teledyne Continental Motors, USA

Terrytune Developments, Ltd., GB

Thermo Electron Corporation, USA

Toyoto Motor Company, Ltd., J

Transport Canada, C

Triad Services, Inc., USA

Tricentrol International, Ltd., GB

TRW Incorporated, USA

Turbokonsult, S

Ultra Electronics, Ltd., GB

Umweltbundesamt, D

United Stirling AB & Co., S

United Turbine AB, S

Universität Trier-Kaiserslautern, D

University of Miami, USA

University of Michigan, USA

University of Tokyo, J

University of Wisconsin, USA

VARTA Batterie AG, D

Volkswagenwerk AG, D

Volvo, S

Wayne State University, USA

White Engineering, USA

Williams Research Corporation, USA

APPENDIX E

IDENTIFICATION OF KEY ORGANIZATIONS

INVOLVED IN PRINCIPAL AREAS OF TECHNICAL ACTIVITY

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IDENTIFICATION OF KEY ORGANIZATIONS
INVOLVED IN PRINCIPAL AREAS OF TECHNICAL ACTIVITY

ACTIVITY: Power Systems and Components

COUNTRY: France

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Institut de Recherche des Transports - Centre d'Evaluation et de Recherche des Nuisances (IRT/CERN)

   ADDRESS 109, avenue Salvador Allende
   69 500 Bron

   RESPONSIBLE INDIVIDUAL Claude Lamure
   TITLE Directeur du C.E.R.N.

   DESCRIPTION OF RESEARCH PROGRAM Studies of hydrostatic transmissions for automobiles and buses

2. OTHER AGENCY Agence pour les Economies d'Energie (A.E.E.)

   ADDRESS 30, rue de Cambronne
   75 015 Paris

   RESPONSIBLE INDIVIDUAL Monsieur Syrota
   TITLE Directeur

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY Délégation Générale à la Recherche Scientifique et Technique (D.G.R.S.T.)

   ADDRESS 35, rue Saint Dominique
   75 700 Paris

   RESPONSIBLE INDIVIDUAL Monsieur Hacq
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Studies of medium and high power transmissions

ACTIVITY (cont.): Power Systems and Components

COUNTRY: France

INDUSTRY CONTACTS:

1. ORGANIZATION Moteur Moderne

   ADDRESS 52, rue de Silly
   92 100 Boulogne

   RESPONSIBLE INDIVIDUAL Monsieur Pichard
   TITLE Directeur des Recherche

   DESCRIPTION OF RESEARCH PROGRAM Studies and improvements on conventional 2 T and 4 T engines; studies of transmissions

2. ORGANIZATION Régie Nationale des Usines Renault (R.N.U.R.)

   ADDRESS 112, rue des Bons Raisins
   92 500 Rueil Malmaison

   RESPONSIBLE INDIVIDUAL Monsieur Maistrelli and Monsieur Gyss
   TITLES Ingénieurs de Recherche

   DESCRIPTION OF RESEARCH PROGRAM Studies on 4 T engines; studies of hydrostatic transmission for automobile (5 to 15 hp)

3. ORGANIZATION Saviem

   ADDRESS 8, quai Léon Blum
   92 152 Suresnes

   RESPONSIBLE INDIVIDUAL Monsieur Lagrange
   TITLE Directeur Technique

   DESCRIPTION OF RESEARCH PROGRAM Study of a hydrostatic transmission for buses

ACTIVITY: Power Systems and Components

COUNTRY: Federal Republic of Germany

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Bundesministerium für Forschung und Technologie -Ref. 522 -

   ADDRESS Postfach 2o o7 o6
   53oo Bonn 2

   RESPONSIBLE INDIVIDUAL Dr. -Ing. J. Bandel
   TITLE Regierungsdirektor

   DESCRIPTION OF RESEARCH PROGRAM Motor vehicles and road traffic

2. OTHER AGENCY Umweltbundesamt

   ADDRESS Bismarckplatz 1
   looo Berlin 33

   RESPONSIBLE INDIVIDUAL Dr. K. Becker
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Traffic Emission Program

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Power Systems and Components

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

1. ORGANIZATION Audi NSU Auto Union AG

   ADDRESS 8o7o Ingolstadt

   RESPONSIBLE INDIVIDUAL Dr. Wilmers
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Stratified Charge Rotary Engine

2. ORGANIZATION Bayerische Motoren Werke AG

   ADDRESS Petuelring 13o
   8ooo München 4o

   RESPONSIBLE INDIVIDUAL F. Hartig
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Compound Engine

3. ORGANIZATION Continental Gummi-Werke AG

   ADDRESS Jädekamp 3o
   3ooo Hannover-Stöcken

   RESPONSIBLE INDIVIDUAL H. Römer
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Research and development of tires for passenger cars

ACTIVITY (cont.): Power Systems and Components

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

4. ORGANIZATION Pierburg Gmbh + CO KG

ADDRESS Leuschstr. 1
4o4o Neuss

RESPONSIBLE INDIVIDUAL Dr. Grossmann
TITLE

DESCRIPTION OF RESEARCH PROGRAM Mixture formation and distribution

5. ORGANIZATION Klöckner-Humboldt-Deutz AG

ADDRESS Postfach
5ooo Köln 21

RESPONSIBLE INDIVIDUAL Finsterwalder
TITLE

DESCRIPTION OF RESEARCH PROGRAM Stratified charge engine on the basis of the AD-system

6. ORGANIZATION Dr.-Ing. h.c. F. Porsche AG

ADDRESS Postfach 4o o6 4o
7ooo Stuttgart 4o

RESPONSIBLE INDIVIDUAL Paletschek
TITLE

DESCRIPTION OF RESEARCH PROGRAM Noise reduction of passenger cars

ACTIVITY (cont.): Power Systems and Components

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

7. ORGANIZATION Volkswagenwerk AG

ADDRESS Postfach
3180 Wolfsburg

RESPONSIBLE INDIVIDUAL P. Hofbauer
TITLE

DESCRIPTION OF RESEARCH PROGRAM Diesel engine for small passenger cars

8. ORGANIZATION Volkswagenwerk AG

ADDRESS Postfach
3180 Wolfsburg

RESPONSIBLE INDIVIDUAL Brandstetter
TITLE

DESCRIPTION OF RESEARCH PROGRAM Stratified charge engine with prechamber injection (PCI)

9. ORGANIZATION Volkswagenwerk AG

ADDRESS Postfach
3180 Wolfsburg

RESPONSIBLE INDIVIDUAL Dr. Walzer
TITLE

DESCRIPTION OF RESEARCH PROGRAM Gas turbine for passenger cars

ACTIVITY (cont.): Power Systems and Components

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

10. ORGANIZATION TU Stuttgart, Forschungsinstitut für Kraftfahrwesen und Fahrzeugmotoren

ADDRESS Martin-Schrenk-Weg 9
7000 Stuttgart 60

RESPONSIBLE INDIVIDUAL Dr. -Ing. U. Essers
TITLE Professor

DESCRIPTION OF RESEARCH PROGRAM Tire Noise

11. ORGANIZATION TU Kaiserslautern, Lehrstuhl für Kraft- und Arbeitsmaschinen

ADDRESS Postfach 3049
6750 Kaiserslautern

RESPONSIBLE INDIVIDUAL Dr. -Ing. H. May
TITLE Professor

DESCRIPTION OF RESEARCH PROGRAM Reaction Kinetics

12. ORGANIZATION RWTH Aachen, Lehrstuhl für Angewandte Thermodynamik

ADDRESS Schinkelstr.
5100 Aachen

RESPONSIBLE INDIVIDUAL Dr. techn. F. Pischinger
TITLE Professor

DESCRIPTION OF RESEARCH PROGRAM Stratified charge engines

ACTIVITY (cont.): Power Systems and Components

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

13. ORGANIZATION Degussa AG

ADDRESS Postfach 602
6450 Hanau 1

RESPONSIBLE INDIVIDUAL Dr. Koberstin
TITLE

DESCRIPTION OF RESEARCH PROGRAM Development of catalysts

14. ORGANIZATION

ADDRESS

RESPONSIBLE INDIVIDUAL
TITLE

DESCRIPTION OF RESEARCH PROGRAM

15. ORGANIZATION

ADDRESS

RESPONSIBLE INDIVIDUAL
TITLE

DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Power Systems and Components

COUNTRY: The Netherlands

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Department of Road Transport

   ADDRESS Fruitweg 262
   2525 KJ Den Haag

   RESPONSIBLE INDIVIDUAL Johan G. Kuiperbak
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. OTHER AGENCY Research Institute for Road Vehicles - TNO

   ADDRESS Schoemakerstraat 97
   2628 VK Delft

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Power Systems and Components

COUNTRY: The Netherlands

INDUSTRY CONTACTS:

1. ORGANIZATION Philips Research Laboratories

   ADDRESS Department of Stirling engines
   5656 AA Eindhoven

   RESPONSIBLE INDIVIDUAL Prof. Holstlaan
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. ORGANIZATION DAF Trucks B.V.

   ADDRESS Geldropseweg 303
   5645 TK Eindhoven

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Power Systems and Components

COUNTRY: United States of America

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Department of Energy

   ADDRESS Division of Transportation Energy Conservation
   20 Massachusetts Avenue, N.W.
   Washington, D.C. 20545

   RESPONSIBLE INDIVIDUAL George M. Thur and/or Paul Lombardi
   TITLE Chief, Heat Engines Systems Branch/Chief, Vehicular Systems Section

   DESCRIPTION OF RESEARCH PROGRAM The Heat Engines Program and the attendant Vehicular Systems Program are developing advanced automobile propulsion systems. The major emphasis is in the development of more efficient vehicular gas turbine and Stirling engines.

2. OTHER AGENCY National Aeronautics and Space Administration (NASA)

   ADDRESS Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135

   RESPONSIBLE INDIVIDUAL Mort Krasner
   TITLE Chief, Transportation Propulsion Division

   DESCRIPTION OF RESEARCH PROGRAM As project management and technical support manager for DOE advanced heat engine programs, NASA provides technical management for contracted efforts in heat engines and transmissions. Also advanced engine research and lab testing is performed.

3. OTHER AGENCY Jet Propulsion Laboratory

   ADDRESS California Institute of Technology
   4800 Oak Grove Drive
   Pasadena, California 90013

   RESPONSIBLE INDIVIDUAL Mr. Gerald Meisenholder
   TITLE Manager, Transportation Systems Office

   DESCRIPTION OF RESEARCH PROGRAM Supportive research and project management in vehicle systems including vehicle test, data acquisition evaluation and analysis.

ACTIVITY (cont.): Power Systems and Components

COUNTRY: United States of America

INDUSTRY CONTACTS:

1. ORGANIZATION Chrysler Corporation

   ADDRESS P.O. Box 1118, CIMS 418-38-31
   Detroit, Michigan 48288

   RESPONSIBLE INDIVIDUAL C. E. Wagner
   TITLE Senior Research Staff Engineer

   DESCRIPTION OF RESEARCH PROGRAM Improved gas turbine is being designed under the DOE program. Improved thermal efficiency, low inertia systems are being designed. Single and two shaft version trade-off studies are being conducted. Also, upgraded turbine work is being continued.

2. ORGANIZATION Orshansky Transmission Co.

   ADDRESS 5141 Santa Fe Street
   San Diego, California 92109

   RESPONSIBLE INDIVIDUAL Peter Huntley
   TITLE Executive Vice President

   DESCRIPTION OF RESEARCH PROGRAM Orshansky is developing continuously variable transmission technology using the split hydromechanical powerpath principles.

3. ORGANIZATION Mechanical Technology, Incorporated

   ADDRESS 968 Albany-Shaker Road
   Latham, New York 12110

   RESPONSIBLE INDIVIDUAL Otto Decker
   TITLE Vice President and General Manager, Engine Systems Division

   DESCRIPTION OF RESEARCH PROGRAM Research and development of a Stirling engine directed toward the Stirling as a viable alternative to existing automobile engines with improved fuel economy, low exhaust emissions and capability to use nonpetroleum based fuels.

ACTIVITY: Power Systems and Components

COUNTRY: Canada (Observer Status)

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Transport Canada Strategic Studies Branch

   ADDRESS 1000 Sherbrooke St. W., P.O. Box 549
   Place de L'Aviation
   Montreal, Quebec H3A 2R3

   RESPONSIBLE INDIVIDUAL G. B. Maund
   TITLE Energy Coordination Officer

   DESCRIPTION OF RESEARCH PROGRAM As below Nos. 2 and 3 Funding management responsibility for both projects and NATO/CCMS Canadian Representative

2. OTHER AGENCY Transport Canada Research and Development Centre

   ADDRESS Technological Branch
   1000 Sherbrooke St. W., P.O. Box 549
   Place de L'Aviation, Montreal, Quebec H3A 2R3

   RESPONSIBLE INDIVIDUAL Mr. E. Rudback and Mr. M. Audette
   TITLE Advanced Technology Program Managers

   DESCRIPTION OF RESEARCH PROGRAM Hybrid Transmission System
   Diesel/flywheel Hybrid Bus Simulation
   Test and Verification of Energy Savings

3. OTHER AGENCY National Research Council

   ADDRESS Division of Mechnical Engineering
   Montreal Road, Ottawa
   Ontario K1A 0R6

   RESPONSIBLE INDIVIDUAL Dr. R. B. Whyte
   TITLE Head Fuel and Lubricants Laboratory

   DESCRIPTION OF RESEARCH PROGRAM Hybrid Transmission System
   Internal Combustion Engine/Hydraulic Accumulator
   Energy Storage System
   Test and Verification of Energy Savings

ACTIVITY (cont.): Power Systems and Components

COUNTRY: Canada

INDUSTRY CONTACTS:

1. ORGANIZATION None

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: High Temperature Ceramic Materials

COUNTRY: France

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Institut de Recherche des Transports - Centre d'Evaluation et de Recherche des Nuisances (IRT/CERN)

   ADDRESS 109, avenue Salvador Allende
   69 500 Bron

   RESPONSIBLE INDIVIDUAL Claude Lamure
   TITLE Directeur du C.E.R.N.

   DESCRIPTION OF RESEARCH PROGRAM

2. OTHER AGENCY Délégation Générale à la Recherche Scientifique et Technique (DGRST)

   ADDRESS 35, rue Saint Dominique
   75 007 Paris

   RESPONSIBLE INDIVIDUAL Monsieur Le Floch
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): High Temperature Ceramic Materials

COUNTRY: France

INDUSTRY CONTACTS:

1. ORGANIZATION Compagnie Générale D'Electricité (C.G.E.)

   ADDRESS Laboratoire de Marcoussis
   91 460 Marcoussis

   RESPONSIBLE INDIVIDUAL Monsieur Dumas
   TITLE Directeur Matériaux

   DESCRIPTION OF RESEARCH PROGRAM Work on silicon carbide and silicon nitride (low temperature sintering)

2. ORGANIZATION CERAVER

   ADDRESS Usine de Bazet
   65 001 Tarbes

   RESPONSIBLE INDIVIDUAL Monsieur Minjolle
   TITLE Directeur Technique

   DESCRIPTION OF RESEARCH PROGRAM Work on mullite and iolite for rotating and stationary heat exchanger (for turbines)

3. ORGANIZATION Société Carbonisation Entreprise et Céramique (C.E.C.)

   ADDRESS 2, avenue Einstein
   78 190 Trappes

   RESPONSIBLE INDIVIDUAL Monsieur Meneret
   TITLE Directeur Technique

   DESCRIPTION OF RESEARCH PROGRAM Study of new ceramic materials (turbine blades)

ACTIVITY: High Temperature Ceramic Materials

COUNTRY: Federal Republic of Germany

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Bundesministerium für Forschung und Technologie - Ref. 3o3 -

   ADDRESS Postfach 2o o7 o6
   53oo Bonn 2

   RESPONSIBLE INDIVIDUAL Dr. G. Sievers
   TITLE Regierungsdirektor

   DESCRIPTION OF RESEARCH PROGRAM Research and development on high temperature materials

2. OTHER AGENCY Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt e.V. (DFVLR)

   ADDRESS Institut für Werkstoff-Forschung
   Postfach 9o 6o 58
   5ooo Koln 9o

   RESPONSIBLE INDIVIDUAL Dr. Bunk
   TITLE Professor

   DESCRIPTION OF RESEARCH PROGRAM Research and development on high temperature materials

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): High Temperature Ceramic Materials

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

1. ORGANIZATION Volkswagenwerk AG

   ADDRESS Postfach
   3180 Wolfsburg

   RESPONSIBLE INDIVIDUAL Dr. Walzer
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM High temperature ceramics for automobile gas turbines

2. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: High Temperature Ceramic Materials

COUNTRY: The Netherlands

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Department of Road Transport

   ADDRESS Fruitweg 262
   2525 KJ Den Haag

   RESPONSIBLE INDIVIDUAL Johan G. Kuiperbak
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): High Temperature Ceramic Materials

COUNTRY: The Netherlands

INDUSTRY CONTACTS:

1. ORGANIZATION None

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: High Temperature Ceramic Materials

COUNTRY: United States of America

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Department of Energy

   ADDRESS Division of Transportation Energy Conservation
   20 Massachusetts Avenue, N.W.
   Washington, D.C. 20545

   RESPONSIBLE INDIVIDUAL George M. Thur and/or Robert B. Schulz
   TITLE Chief, Heat Engine Systems Branch/Program Manager, Stirling Engines

   DESCRIPTION OF RESEARCH PROGRAM The DOE Heat Engine Highway Vehicle Systems Project has as one objective to develop advanced high temperature materials technology by 1983 to greatly improve the efficiency of gas turbine and Stirling engines. Project responsibility has been delegated to NASA Lewis Research Center.

2. OTHER AGENCY National Aeronautics and Space Administration (NASA)

   ADDRESS Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135

   RESPONSIBLE INDIVIDUAL Morton Krasner and/or Charles Blankenship
   TITLE Chief, Transportation Propulsion Division/Chief, Materials Application Branch

   DESCRIPTION OF RESEARCH PROGRAM The DOE/NASA Continuous Combustion Highway Vehicles Program is directed toward automobile gas turbine and Stirling engines. Major engine development contractors include Detroit Diesel Allison, Chrysler Corporation and Ford Motor Company. Ceramic materials projects are in the areas of characterization, improved materials and component design, fabrication, and testing.

3. OTHER AGENCY Department of Defense (DOD)

   ADDRESS Army Materials and Mechanics Research Center (AMMRC)
   Watertown, Massachusetts 02172

   RESPONSIBLE INDIVIDUAL Robert Katz and/or Edward Lenoe
   TITLE Chief, Ceramic Materials/Chief, Mechanics of Materials Division

   DESCRIPTION OF RESEARCH PROGRAM The Heat Engine Highway Systems Materials and Components Technology Program supports DOE/NASA. Major activities are continuation of ARPA/DOE brittle materials design effort at Ford, and other work on sinterable silicon nitride, characterization of turbine ceramics, and proof testing life prediction methodology.

ACTIVITY (cont.): High Temperature Ceramic Materials

COUNTRY: United States of America

INDUSTRY CONTACTS:

1. ORGANIZATION Ford Motor Company

   ADDRESS Scientific Research Laboratory
   P.O. Box 2053
   Dearborn, Michigan 48121

   RESPONSIBLE INDIVIDUAL A. F. McLean
   TITLE Manager, Turbine Development Department

   DESCRIPTION OF RESEARCH PROGRAM The effort includes the advancement of ceramic rotor technology under the ARPA/DOE Brittle Materials Design Project, brittle material design methodology development, and regenerator development.

2. ORGANIZATION General Motors Corporation

   ADDRESS Detroit Diesel Allison Division
   P. O. Box 894
   Indianapolis, Indiana 46206

   RESPONSIBLE INDIVIDUAL H. E. Helms
   TITLE Chief Project Engineer, Advanced Gas Turbines

   DESCRIPTION OF RESEARCH PROGRAM The DOE/NASA Improved Heavy Duty Gas Turbine Engine Program involves the introduction of ceramic components into the hot flow path of this engine including regenerator, gasifier nozzle, shrouds, combustor plenum and rotor blades.

3. ORGANIZATION Chrysler Corporation

   ADDRESS P. O. Box 1118, CIMS 418-38-31
   Detroit, Michigan 48288

   RESPONSIBLE INDIVIDUAL C. E. Wagner
   TITLE Senior Research Staff Engineer

   DESCRIPTION OF RESEARCH PROGRAM The upgraded gas turbine engine is being developed under the DOE Baseline Gas Turbine Program. Ceramic regenerators have been incorporated into this engine and other hot flow components are being investigated for the improved engine.

ACTIVITY: High Temperature Ceramic Materials

COUNTRY: Canada (Observer Status)

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY National Aeronautical Establishment

   ADDRESS Montreal Road
   Ottawa
   Ontario K1A ORG

   RESPONSIBLE INDIVIDUAL Dr. W. Wallace
   TITLE Head of materials section, Structures & Materials Laboratory

   DESCRIPTION OF RESEARCH PROGRAM Development of high temperature turbine components by the following techniques:
   a) Powder metallurgy forming by hot isostatic pressure
   b) Super plastic forgings
   c) Isothermal forgings
   d) Fibre reinforcing (tungsten reinforced nickel based super alloys)
   e) Oxide dispersion strengthened alloys

2. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): High Temperature Ceramic Materials

COUNTRY: Canada

INDUSTRY CONTACTS:

1. ORGANIZATION via Dr. Wallace - see "Government Contacts"

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Alternative Fuels

COUNTRY: France

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY: Ministère de l'Industrie - Direction des Carburants

   ADDRESS 5, rue Barbet de Jouy
   75 700 Paris

   RESPONSIBLE INDIVIDUAL Monsieur Piketty
   TITLE Directeur

   DESCRIPTION OF RESEARCH PROGRAM

2. OTHER AGENCY Agence pour les Economies d'Energie (A.E.E.)

   ADDRESS 30, rue de Cambronne
   75 015 Paris

   RESPONSIBLE INDIVIDUAL Monsieur Syrota
   TITLE Directeur

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY Institut de Recherche des Transports - Centre d'Evaluation et de Recherche des Nuisances (IRT/CERN)

   ADDRESS 109, avenue Salvador Allende
   69 500 Bron

   RESPONSIBLE INDIVIDUAL Jean Delsey
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Hydrogen storage capabilities - Study of the use of Fuels derived from coal

ACTIVITY (cont.): Alternative Fuels

COUNTRY: France

INDUSTRY CONTACTS:

1. ORGANIZATION Institut Francais du Pétrole (I.F.P.)

   ADDRESS 1.4. avenue de Bois Préau
   92 506 Rueil Malmaison Cedex

   RESPONSIBLE INDIVIDUAL Monsieur Bernard Sale
   TITLE Directeur des Applications Moteurs

   DESCRIPTION OF RESEARCH PROGRAM Bench testing on engine and on vehicles of fuels such as methanol, hydrogen, petroleum gas, natural gas

2. ORGANIZATION Moteur Moderne

   ADDRESS 52, rue de Silly
   92 100 Boulogne

   RESPONSIBLE INDIVIDUAL Monsieur Pichard
   TITLE Directeur des Recherches

   DESCRIPTION OF RESEARCH PROGRAM Partial gasification of gasoline at the level of the controlled ignition engine

3. ORGANIZATION C.E.A. - C.E.N.G.

   ADDRESS Avenue des Martyrs
   38 041 Grenoble

   RESPONSIBLE INDIVIDUAL Monsieur Perroud
   TITLE Directeur des Applications Spéciales

   DESCRIPTION OF RESEARCH PROGRAM Use of hydrogen in combustion engines; storage in forms of metallic hydrides

ACTIVITY: Alternative Fuels

COUNTRY: Federal Republic of Germany

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Bundesministerium für Forschung und Technologie - Ref. 522 -

   ADDRESS Postfach 2o o7 o6
   53oo Bonn 2

   RESPONSIBLE INDIVIDUAL Dr.-Ing. J. Bandel
   TITLE Regierungsdirektor

   DESCRIPTION OF RESEARCH PROGRAM Motor vehicles and road traffic

2. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Alternative Fuels

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

1. ORGANIZATION Volkswagenwerk AG

   ADDRESS Postfach
   3180 Wolfsburg

   RESPONSIBLE INDIVIDUAL Dr. -Ing. W. Bernhardt
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Alcohol-gasoline blends, methyl-fuel-operation

2. ORGANIZATION Badische Anilin- und Sodafabrik AG

   ADDRESS Carl-Bosch-Strasse
   6700 Ludwigshafen

   RESPONSIBLE INDIVIDUAL K. Starke
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Methanol/water-gasoline dual fuel operation

3. ORGANIZATION ARAL AG

   ADDRESS Postfach 450
   4630 Bochum

   RESPONSIBLE INDIVIDUAL B. Nierhauve
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Methyl fuel optimization, production and distribution

ACTIVITY (cont.): Alternative Fuels

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

4. ORGANIZATION Daimler-Benz AG

ADDRESS Postfach 2o2
7ooo Stuttgart 6o

RESPONSIBLE INDIVIDUAL Dr. Buchner
TITLE

DESCRIPTION OF RESEARCH PROGRAM Metal hydrides for hydrogen storage in passenger cars

5. ORGANIZATION Daimler-Benz AG

ADDRESS Postfach 2o2
7ooo Stuttgart 6o

RESPONSIBLE INDIVIDUAL D. Gwinner
TITLE

DESCRIPTION OF RESEARCH PROGRAM Hydrogen engine

6. ORGANIZATION TU Kaiserslautern, Lehrstuhl für Kraft- und Arbeitsmachinen

ADDRESS Postfach 3o49
675o Kaiserslautern

RESPONSIBLE INDIVIDUAL Dr. -Ing. H. May
TITLE Professor

DESCRIPTION OF RESEARCH PROGRAM Hydrogen-gasoline dual fuel operation

ACTIVITY: Alternative Fuels

COUNTRY: The Netherlands

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Department of Road Transport

   ADDRESS Fruitweg 262
   2525 KJ Den Haag

   RESPONSIBLE INDIVIDUAL Johan G. Kuiperbak
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. OTHER AGENCY Research Institute for Road Vehicles - TNO

   ADDRESS Schoemakerstraat 97
   2628 VK Delft

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Alternative Fuels

COUNTRY: The Netherlands

INDUSTRY CONTACTS:

1. ORGANIZATION None

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Alternative Fuels

COUNTRY: United States of America

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Department of Energy

   ADDRESS Division of Transportation Energy Conservation
   20 Massachusetts Avenue, N.W.
   Washington, D.C. 20545

   RESPONSIBLE INDIVIDUAL E. Eugene Ecklund
   TITLE Chief, Alternative Fuels Branch

   DESCRIPTION OF RESEARCH PROGRAM To provide options for replacement of petroleum as fuel for highway vehicles, with the primary candidates being fuels from synthetic crudes (from coal and/or oil shale), alcohols (straight and blended in gasoline), and hydrogen.

2. OTHER AGENCY Department of Energy, Bartlesville Energy Research Center

   ADDRESS P.O. Box 1398
   Bartlesville, Oklahoma 74003

   RESPONSIBLE INDIVIDUAL Richard Hurn
   TITLE Research Supervisor

   DESCRIPTION OF RESEARCH PROGRAM Investigation of alcohol fuels and synthetic fuels in engines in support of headquarters (DOE Washington) programs.

3. OTHER AGENCY U.S. Army Fuels and Lubricants Research Laboratory

   ADDRESS P.O. Drawer 28510
   San Antonio, Texas 78284

   RESPONSIBLE INDIVIDUAL Sidney J. Lestz
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Evaluation of engine lubricants when used in engines fuels with petroleum substitutes. Present emphasis is on alcohol fuels and includes achieving a suitable additive package.

ACTIVITY (cont.): Alternative Fuels

COUNTRY: United States of America

INDUSTRY CONTACTS:

1. ORGANIZATION University of Santa Clara

   ADDRESS Mechanical Engineering Department
   Santa Clara, California 95053

   RESPONSIBLE INDIVIDUAL Professor Richard K. Pefley
   TITLE Chairman, Mechanical Engineering Department

   DESCRIPTION OF RESEARCH PROGRAM Research and applications on use of straight alcohol fuels in automotive engines, including some work on photochemical smog from exhaust emissions and methanol effects on aquatic environment.

2. ORGANIZATION University of Miami

   ADDRESS Department of Mechanical and Industrial Engineering
   Coral Gables, Florida 33124

   RESPONSIBLE INDIVIDUAL Dr. Robert R. Adt, Jr.
   TITLE Professor, Mechanical Engineering

   DESCRIPTION OF RESEARCH PROGRAM Research and applications on use of alcohol/gasoline blends in automotive engines, with emphasis on basic phenomena including identification of various hydrocarbon emission species.

3. ORGANIZATION Union Oil of California

   ADDRESS P.O. Box 76
   Brea, California 92621

   RESPONSIBLE INDIVIDUAL Edward L. Wiseman
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Investigation of methods of solving problems in use of alcohol fuels by means of modifying the fuel composition. Addresses both methanol and ethanol, straight and blends with gasoline.

ACTIVITY (cont.): Alternative Fuels

COUNTRY: United States of America

INDUSTRY CONTACTS:

4. ORGANIZATION Solar Turbines International Group

ADDRESS 2200 Pacific Highway
San Diego, California 92138

RESPONSIBLE INDIVIDUAL Dr. David Rohy
TITLE

DESCRIPTION OF RESEARCH PROGRAM Modification of magnesium-based metal hydrides to provide dissociation at temperatures where exhaust heat from vehicle engines can be used to release stored hydrogen fuel

5. ORGANIZATION University of Miami

ADDRESS Department of Mechanical and Industrial Engineering
Coral Gables, Florida 33124

RESPONSIBLE INDIVIDUAL Dr. Robert R. Adt, Jr.
TITLE Professor, Mechanical Engineering

DESCRIPTION OF RESEARCH PROGRAM Determine data on use of hydrogen in automotive engines which will permit engineers to design a true hydrogen-fueled engine

6. ORGANIZATION Pennsylvania State University

ADDRESS 302 Mechanical Engineering Building
University Park, Pennsylvania 16802

RESPONSIBLE INDIVIDUAL Dr. Samuel S. Lestz
TITLE Professor of Mechanical Engineering

DESCRIPTION OF RESEARCH PROGRAM Investigate basic phenomena of fumigating alcohol with air into a diesel combustion chamber to supplement diesel pilot fuel

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ACTIVITY: Alternative Fuels

COUNTRY: Canada (Observer Status)

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Transport Canada, Strategic Studies Branch

   ADDRESS Floor 25, 1000 Sherbrooke Street West, P.O. Box 549
   Place de l'Aviation
   Montreal, Quebec H3A 2R3

   RESPONSIBLE INDIVIDUAL G. B. Maund
   TITLE Energy Coordination Officer

   DESCRIPTION OF RESEARCH PROGRAM Identification of alternative automotive fuels; qualification of availability and time period; assessment of end use technologies inclusive of road trials under Canadian climatic conditions. Principal concerns: a) methanol from natural gas or biomass versus synthetic fuels from natural gas/coal/tar sand, b) matching end use technologies

2. OTHER AGENCY Energy Mines and Resources, Renewable Energy Resources Branch

   ADDRESS Room A 1706
   580 Booth Street
   Ottawa, Ontario K1A OE4

   RESPONSIBLE INDIVIDUAL Dr. H. Swain
   TITLE Senior Branch Advisor

   DESCRIPTION OF RESEARCH PROGRAM a) As above - fuel sources and derived synthetic liquid transportation fuels, b) Renewable fuels studies, e.g., methanol from biomass

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Alternative Fuels

COUNTRY: Canada

INDUSTRY CONTACTS:

1. ORGANIZATION None

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Electric and Hybrid Vehicle Systems

COUNTRY: France

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Institut de Recherche des Transports

   ADDRESS 2, avenue du Général Malleret Joinville
   94 114 Arcueil Cedex

   RESPONSIBLE INDIVIDUAL Michel Frybourg
   TITLE Directeur de l'Institut de Recherche des Transports

   DESCRIPTION OF RESEARCH PROGRAM Research on capabilities of electric and hybrid vehicles

2. OTHER AGENCY Ministère de la Culture et de l'Environnement

   ADDRESS 14, Boulevard du Général Leclerc
   92 521 Neuilly

   RESPONSIBLE INDIVIDUAL Monsieur Muller
   TITLE Chargé de Mission

   DESCRIPTION OF RESEARCH PROGRAM Development of different types of electrical vehicles

3. OTHER AGENCY Délégation Générale à la Recherche Scientifique et Techniques (D.G.R.S.T.)

   ADDRESS 35, rue Saint Dominique
   75 700 Paris

   RESPONSIBLE INDIVIDUAL Monsieur Le Floch
   TITLE Chargé de Mission

   DESCRIPTION OF RESEARCH PROGRAM Electrochemical generators of all powers

ACTIVITY (cont.): Electric and Hybrid Vehicle Systems

COUNTRY: France

INDUSTRY CONTACTS:

1. ORGANIZATION Société BERTIN

   ADDRESS Allée Gabriel Voisin
   78 370 Plaisir

   RESPONSIBLE INDIVIDUAL Monsieur Lapautre
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Feasibility studies; prototype production of small electric vehicles (urban vehicles); feasibility studies of hybrid vehicles

2. ORGANIZATION Compagnie Générale d'Electricité (C.G.E.)

   ADDRESS Laboratoires de Marcoussis
   91 460 Marcoussis

   RESPONSIBLE INDIVIDUAL Monsieur Vic
   TITLE Directeur de la Division Electrochimie

   DESCRIPTION OF RESEARCH PROGRAM Feasibility studies; investigations on high performance (Sodium-sulfur) storage batteries

3. ORGANIZATION Institut Francais du Pétrole (I.F.P.)

   ADDRESS 1.4. avenue de Bois Préau
   92 506 Rueil Malmaison Cedex

   RESPONSIBLE INDIVIDUAL Monsieur Breelle
   TITLE Responsable des recherches piles à combustible

   DESCRIPTION OF RESEARCH PROGRAM Investigations on hydrogen-air fuel cells

ACTIVITY: Electric and Hybrid Vehicle Systems (Hybrid)

COUNTRY: Federal Republic of Germany

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Bundesministerium für Foschung und Technologie - Ref. 522 -

   ADDRESS Postfach 2o o7 o6
   53oo Bonn 2

   RESPONSIBLE INDIVIDUAL Dr. -Ing. J. Bandel
   TITLE Regierungsdirektor

   DESCRIPTION OF RESEARCH PROGRAM Motor vehicles and road traffic

2. OTHER AGENCY Bundesministerium für Verkehr

   ADDRESS Postfach 2o ol oo
   53oo Bonn 2

   RESPONSIBLE INDIVIDUAL Bartsch
   TITLE Bundesbahnoberrat

   DESCRIPTION OF RESEARCH PROGRAM Demonstration project 2o hybrid busses

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Electric and Hybrid Vehicle Systems (Hybrid)

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

1. ORGANIZATION Daimler-Benz AG

   ADDRESS Postfach 2o2
   7ooo Stuttgart 6o

   RESPONSIBLE INDIVIDUAL Dr. P. Strifler
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Diesel engine with flywheel

2. ORGANIZATION Maschinenfabrik Augsburg-Nürnberg AG

   ADDRESS Postfach 5o o6 2o
   8ooo München 5o

   RESPONSIBLE INDIVIDUAL P. Merker
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Diesel engine with flywheel

3. ORGANIZATION Robert Bosch GmbH

   ADDRESS Postfach 5o
   7ooo Stuttgart 3o

   RESPONSIBLE INDIVIDUAL H. Schneider
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Diesel engine with flywheel

ACTIVITY (cont.): Electric and Hybrid Vehicle Systems (Hybrid)

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

4. ORGANIZATION RWTH Aachen, Institut für Kraftfahrwesen

ADDRESS Templergraben 55
5100 Aachen

RESPONSIBLE INDIVIDUAL Dr.-Ing. Helling
TITLE Professor

DESCRIPTION OF RESEARCH PROGRAM Diesel engine with flywheel

5. ORGANIZATION TU Berlin, Institut für Landverkehrsmittel

ADDRESS Strasse des 17. Juni 135
1000 Berlin 12

RESPONSIBLE INDIVIDUAL Dr.-Ing. H.-P. Willumeit
TITLE

DESCRIPTION OF RESEARCH PROGRAM Diesel engine with flywheel

6. ORGANIZATION

ADDRESS

RESPONSIBLE INDIVIDUAL
TITLE

DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Electric and Hybrid Vehicle Systems (Electric)

COUNTRY: Federal Republic of Germany

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Bundesministerium für Verkehr

   ADDRESS Postfach 2o o1 oo
   53oo Bonn 2

   RESPONSIBLE INDIVIDUAL Bartsch
   TITLE Bundesbahnoberrat

   DESCRIPTION OF RESEARCH PROGRAM Research and development on electric and hybrid vehicles

2. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Electric and Hybrid Vehicle Systems (Electric)

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

1. ORGANIZATION Gesellschaft für den elektrischen Strassenverkehr (GES)

   ADDRESS Tersteegenstr. 77
   4000 Dusseldorf 30

   RESPONSIBLE INDIVIDUAL Dr. H. -G. Muller
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Research and development on electric vehicles

2. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Electric and Hybrid Vehicle Systems

COUNTRY: The Netherlands

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Department of Road Transport

   ADDRESS Fruitweg 262
   2525 KJ Den Haag

   RESPONSIBLE INDIVIDUAL Johan G. Kuiperbak
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. OTHER AGENCY Research Institute for Road Vehicles - TNO

   ADDRESS Schoemakerstraat 97
   2628 VK Delft

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Electric and Hybrid Vehicle Systems

COUNTRY: The Netherlands

INDUSTRY CONTACTS:

1. ORGANIZATION None

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Electric and Hybrid Vehicle Systems

COUNTRY: United States of America

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Department of Energy

   ADDRESS Division of Transportation Energy Conservation
   20 Massachusetts Avenue, N.W.
   Washington, D.C. 20545

   RESPONSIBLE INDIVIDUAL Paul J. Brown
   TITLE Assistant Director, Electric and Hybrid Vehicle Systems

   DESCRIPTION OF RESEARCH PROGRAM Integrated RDT&E of batteries, components, propulsion systems and total vehicle systems for electric and/or hybrid passenger cars and commercial vans. Program includes an 8-year demonstration of 10,000 electric and hybrid vehicles.

2. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Electric and Hybrid Vehicle Systems

COUNTRY: United States of America

INDUSTRY CONTACTS:

1. ORGANIZATION Electric Vehicle Assoc.

   ADDRESS 9100 Bank Street
   Cleveland, Ohio 44125

   RESPONSIBLE INDIVIDUAL Mr. William Harhay
   TITLE President

   DESCRIPTION OF RESEARCH PROGRAM R&D of conversions of ICE's to electric vehicles; improved safety standards compliance and vehicle performance.

2. ORGANIZATION General Motors Corporation

   ADDRESS GM Research Laboratories
   Warren, Michigan 48090

   RESPONSIBLE INDIVIDUAL Paul D. Larson
   TITLE Chief Engineer, Electric Vehicles

   DESCRIPTION OF RESEARCH PROGRAM Development of electric commercial van. GM is also conducting R&D on advanced batteries, electric passenger cars.

3. ORGANIZATION Gould, Inc.

   ADDRESS 30 Gould Center
   Rolling Meadows, Illinois 60006

   RESPONSIBLE INDIVIDUAL Mr. John McClung
   TITLE Manager, Electric Vehicles

   DESCRIPTION OF RESEARCH PROGRAM Research, development, pilot production line, vehicle systems propulsion systems for electric vehicles.

ACTIVITY: Electric and Hybrid Vehicle Systems

COUNTRY: Canada (Observer Status)

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Transport Canada, Strategic Studies Branch

   ADDRESS 1000 Sherbrooke St. W., P.O. Box 549
   Place de L'Aviation
   Montreal, Quebec, H3A 2R3

   RESPONSIBLE INDIVIDUAL G. B. Maund
   TITLE Energy Coordination Officer

   DESCRIPTION OF RESEARCH PROGRAM As below No. 2
   Funding management responsibility and NATO/CCMS Canadian Representative.

2. OTHER AGENCY Transport Canada Research and Development Centre

   ADDRESS Technology Branch, 1000 Sherbrooke St. W., P.O. Box 549
   Place de L'Aviation
   Montreal, Quebec, H3A 2R3

   RESPONSIBLE INDIVIDUAL E. Rudback and E. Erdelyi
   TITLE Advanced Technology Managers

   DESCRIPTION OF RESEARCH PROGRAM Limited range electric vehicles - Canadian feasibility study.

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Electric and Hybrid Vehicle Systems

COUNTRY: Canada

INDUSTRY CONTACTS:

1. ORGANIZATION None

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Harmonization of Emission Standards and Procedures

COUNTRY: France

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Direction des Routes et de la Circulation Routière (D.R.C.R.)

   ADDRESS 6, rue du Théâtre
   75 015 Paris

   RESPONSIBLE INDIVIDUAL Monsieur Gauvin
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Studies of new procedures for regulation of noise transmissions from vehicles

2. OTHER AGENCY Agence pour les Economies d'Energie (A.E.E.)

   ADDRESS 30, rue de Cambronne
   75 015 Paris

   RESPONSIBLE INDIVIDUAL Monsieur Syrota
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM New certification procedures for fuel consumption

3. OTHER AGENCY Institut de Recherche des Transports (I.R.T.)

   ADDRESS 2, avenue du Général Malleret Joinville
   94 114 Arcueil Cedex

   RESPONSIBLE INDIVIDUAL Michel Frybourg
   TITLE Directeur de l'Institut de Recherche des Transports

   DESCRIPTION OF RESEARCH PROGRAM Studies of relationships between noise transmissions from vehicles, specified by regulations, and the impact of traffic noise on the population

ACTIVITY (cont.): Harmonization of Emission Standards and Procedures

COUNTRY: France

INDUSTRY CONTACTS:

1. ORGANIZATION Union Technique de l'Automobile et du Cycle (U.T.A.C.)

   ADDRESS 157 - 159, rue Lecourbe
   75 015 Paris

   RESPONSIBLE INDIVIDUAL Monsieur Le Guen
   TITLE Responsable des Essais

   DESCRIPTION OF RESEARCH PROGRAM Certification testing of vehicles in the field of consumption, pollution and noise

2. ORGANIZATION Régie Nationale des Usines RENAULT (R.N.U.R.)

   ADDRESS 112, rue des Bons Raisins
   92 500 Rueil Malmaison

   RESPONSIBLE INDIVIDUAL Monsieur Fontanet
   TITLE Directeur des Recherches

   DESCRIPTION OF RESEARCH PROGRAM Analysis of actual operating modes of automobile vehicles in urban areas

3. ORGANIZATION Automobiles BERLIET

   ADDRESS Direction des Etudes et Recherches
   69 635 Venissieux

   RESPONSIBLE INDIVIDUAL Monsieur Soret
   TITLE Directeur des Recherche

   DESCRIPTION OF RESEARCH PROGRAM Study of utilization modes of highway vehicles on different actual lines of communication

ACTIVITY: Harmonization of Emission Standards and Procedures

COUNTRY: Federal Republic of Germany

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Bundesministerium des Innern/Umweltbundesamt

   ADDRESS Umweltbundesamt
   Bismarckplatz 1
   1000 Berlin 33

   RESPONSIBLE INDIVIDUAL Dr. Becker / Dr. Kemper
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Exhaust and noise emission control

2. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Harmonization of Emission Standards and Procedures

COUNTRY: Federal Republic of Germany

INDUSTRY CONTACTS:

1. ORGANIZATION Rheinisch Westfälischer Technischer Überwachungs-Verein e.V.

   ADDRESS Postfach 7o41
   43oo Essen 1

   RESPONSIBLE INDIVIDUAL Krügel
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Emission control of Diesel and Otto Engines

2. ORGANIZATION Technischer Überwachungs-Verein Rheinland e.V.

   ADDRESS Postfach 1o 17 5o
   5000 Köln 1

   RESPONSIBLE INDIVIDUAL Dr. Waldeyer
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM Emission measurement of in-use cars

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Harmonization of Emission Standards and Procedures

COUNTRY: The Netherlands

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Ministry of Environment

   ADDRESS Department of Air Quality
   Dokter Reyersstraat 12
   2265 BA Leidschendam

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. OTHER AGENCY Department of Road Transport

   ADDRESS Fruitweg 262
   2525 KJ Den Haag

   RESPONSIBLE INDIVIDUAL Johan G. Kuiperbak
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Harmonization of Emission Standards and Procedures

COUNTRY: The Netherlands

INDUSTRY CONTACTS:

1. ORGANIZATION None

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

2. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

3. ORGANIZATION

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Harmonization of Emission Standards and Procedures

COUNTRY: United States of America

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY U.S. Environmental Protection Agency

   ADDRESS Division of Emission Control Technology
   2565 Plymouth Road
   Ann Arbor, Michigan 48105

   RESPONSIBLE INDIVIDUAL Merrill W. Korth
   TITLE Mechanical Engineer, Standards Development & Support Branch

   DESCRIPTION OF RESEARCH PROGRAM Develops U.S. motor vehicle emission regulations, standards, and test procedures.

   (U.S. representative to GRPA)

2. OTHER AGENCY Group of Rapporteurs on Air Pollution (GRPA)

   ADDRESS Economic Commission for Europe
   United Nations
   Geneva, Switzerland

   RESPONSIBLE INDIVIDUAL M. B. Gauvin
   TITLE President

   DESCRIPTION OF RESEARCH PROGRAM Develops international motor vehicle emission regulations, standards and test procedures.

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Harmonization of Emission Standards and Procedures

COUNTRY: United States of America

INDUSTRY CONTACTS:

1. ORGANIZATION International Standards Organization
TC 22/SC 5-Road Vehicles/Engine Tests

ADDRESS Society of Automotive Engineers, Inc.
2100 West Big Beaver
Troy, Michigan 48084

RESPONSIBLE INDIVIDUAL R. T. Northrup
TITLE U.S. Secretary

DESCRIPTION OF RESEARCH PROGRAM Developments standards and procedures for road vehicle emissions and power measurement.

2. ORGANIZATION International Standards Organization
TC 22/SC 5/WG 2 - Vehicle Emission Test Methods

ADDRESS Society of Automotive Engineers, Inc.
2100 West Big Beaver
Troy, Michigan 48084

RESPONSIBLE INDIVIDUAL R. T. Northrup
TITLE U.S. Secretary

DESCRIPTION OF RESEARCH PROGRAM Develops motor vehicle emission test methods under the direction of TC22/SC5.

3. ORGANIZATION

ADDRESS

RESPONSIBLE INDIVIDUAL
TITLE

DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY: Harmonization of Emission Standards and Procedures

COUNTRY: Canada (Observer Status)

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Transport Canada, Road & Motor Vehicle Safety Branch

   ADDRESS Tower "C" 27 Floor
   Place de Ville
   Ottawa, Ontario, K1A ON5

   RESPONSIBLE INDIVIDUAL Dr. G. D. Campbell
   TITLE Director

   DESCRIPTION OF RESEARCH PROGRAM Responsible for emission standards and procedures

2. OTHER AGENCY Department of Fisheries and Environment

   ADDRESS 12th Floor, Place Vincent Massey
   Ottawa, Ontario, K1A 1CR

   RESPONSIBLE INDIVIDUAL Mr. A. Gullon
   TITLE Chief, Mobile Sources Division

   DESCRIPTION OF RESEARCH PROGRAM Monitoring exhaust emission and fuel economy of vehicles by measurement

3. OTHER AGENCY Transport Canada, Strategic Studies Branch

   ADDRESS Floor 25, 1000 Sherbrooke Street, W.
   P.O. Box 549, Place de L'Aviation
   Montreal, Quebec, H3A 2R3

   RESPONSIBLE INDIVIDUAL G. B. Maund
   TITLE Energy Coordination Officer

   DESCRIPTION OF RESEARCH PROGRAM NONE - Is NATO/CCMS Canadian Representative

ACTIVITY (cont.): Harmonization of Emission Standards and Procedures

COUNTRY: Canada

INDUSTRY CONTACTS:

1. ORGANIZATION None

   ADDRESS _____

   RESPONSIBLE INDIVIDUAL _____
   TITLE _____

   DESCRIPTION OF RESEARCH PROGRAM _____

2. ORGANIZATION _____

   ADDRESS _____

   RESPONSIBLE INDIVIDUAL _____
   TITLE _____

   DESCRIPTION OF RESEARCH PROGRAM _____

3. ORGANIZATION _____

   ADDRESS _____

   RESPONSIBLE INDIVIDUAL _____
   TITLE _____

   DESCRIPTION OF RESEARCH PROGRAM _____

ACTIVITY: Diesel Engine Noise

COUNTRY: France

GOVERNMENT CONTACTS:

1. PRIMARY AGENCY Institut de Recherche des Transport - Centre d'Evaluation et Recherche des Nuisances (IRT/CERN)

   ADDRESS 109, avenue Salvador Allende
   69 500 Bron

   RESPONSIBLE INDIVIDUAL Claude Lamure
   TITLE Directeur du C.E.R.N.

   DESCRIPTION OF RESEARCH PROGRAM Investigation of industrial capabilities for reducing to 98 dB(A) the noise level emitted by heavy vehicles according to the International Standards Organization procedure

2. OTHER AGENCY Ministère de l'Environnement et de la Culture

   ADDRESS 14, Boulevard du Général Leclerc
   92 521 Neuilly

   RESPONSIBLE INDIVIDUAL Monsieur Monin
   TITLE Chef du Service du Bruit - Ministère de la Culture et de l'Environnement

   DESCRIPTION OF RESEARCH PROGRAM

3. OTHER AGENCY

   ADDRESS

   RESPONSIBLE INDIVIDUAL
   TITLE

   DESCRIPTION OF RESEARCH PROGRAM

ACTIVITY (cont.): Diesel Engine Noise

COUNTRY: France

INDUSTRY CONTACTS:

1. ORGANIZATION Automobiles PEUGEOT

   ADDRESS 18, rue des Fauvelles
   92 250 La Garenne-Colombes

   RESPONSIBLE INDIVIDUAL Monsieur Marty
   TITLE Directeur des Etudes et Recherches

   DESCRIPTION OF RESEARCH PROGRAM Study of noise sources from automobiles; testing of acoustic screens

2. ORGANIZATION Automobiles BERLIET

   ADDRESS Direction des Etudes et Recherches
   69 635 Venissieux

   RESPONSIBLE INDIVIDUAL Monsieur Soret
   TITLE Directeur des Recherches

   DESCRIPTION OF RESEARCH PROGRAM Study of noise sources from heavy vans and buses; production of acoustic screens and soundproofing kits

3. ORGANIZATION METRAVIB

   ADDRESS 36, chemin des Mouilles
   69 130 Ecully

   RESPONSIBLE INDIVIDUAL Monsieur Martinat
   TITLE Directeur Général

   DESCRIPTION OF RESEARCH PROGRAM Methodological analysis of different noise sources on one vehicle

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